NOV 29 1924

Vol. 21, No. 11 *PSYCHOLOGICAL REVIEW PUBLICATIONS* November, 1924

Psychological Bulletin

EDITED BY
SAMUEL W. FERNBERGER, Univ. of Pennsylvania

HOWARD C. WARREN, Princeton University (*Review*)
JOHN B. WATSON, New York (*J. of Exp. Psych.*)
SHEPHERD I. FRANZ, Univ. of Calif., So. Br. (*Monographs*)
MADISON BENTLEY, University of Illinois (*Index*)

WITH THE CO-OPERATION OF

B. T. BALDWIN, University of Iowa; W. V. BINGHAM, Carnegie Institute of Technology; J. E. COOVER, Stanford University; W. T. HERON, University of Kansas; K. S. LASHLEY, University of Minnesota; J. H. LEUBA, Bryn Mawr College; M. F. MEYER, University of Missouri; R. M. OGDEN, Cornell University; R. S. WOODWORTH, Columbia University.

CONTENTS

General Reviews and Summaries:
Recent Acoustic Research: C. A. Ruckmick, 605. *Graphic Functions:* J. E. Downer, 634.
Special Reviews: 643–659.
Notes and News: 660.

PUBLISHED MONTHLY BY THE
PSYCHOLOGICAL REVIEW COMPANY
372–374 BROADWAY, ALBANY, N. Y.
AND PRINCETON, N. J.

Agents: G. E. STECHERT & CO., London (2 Star Yard, Carey St., W.C.); Paris (16, rue de Condé)

Entered as second-class matter at the post-office at Albany, N. Y., September 25, 1922

Psychological Review Publications

EDITED BY

HOWARD C. WARREN, Princeton University (*Review*)
JOHN B. WATSON, 244 Madison Ave., New York (*J. of Exp. Psych.*)
SHEPHERD I. FRANZ, Univ. of Calif., So. Br. (*Monographs*)
MADISON BENTLEY, University of Illinois (*Index*)
SAMUEL W. FERNBERGER, Univ. of Penn. (*Bulletin*)
WITH THE CO-OPERATION OF
Many Distinguished Psychologists

PSYCHOLOGICAL REVIEW

containing original contributions only, appears bi-monthly, January, March, May, July, September, and November, the six numbers comprising a volume of about 480 pages.

PSYCHOLOGICAL BULLETIN

containing abstracts, critical reviews of books and articles, psychological news and notes, university notices, and announcements, appears monthly, the annual volume comprising about 720 pages. Special issues of the Bulletin consist of general reviews of recent work in some department of psychology.

JOURNAL OF EXPERIMENTAL PSYCHOLOGY

containing original contributions of an experimental character, appears bi-monthly, February, April, June, August, October, and December, the six numbers comprising a volume of about 480 pages.

PSYCHOLOGICAL INDEX

is a compendious bibliography of books, monographs, and articles upon psychological and cognate topics that have appeared during the year. The Index is issued annually in May, and may be subscribed for in connection with the periodicals above, or purchased separately.

PSYCHOLOGICAL MONOGRAPHS

consist of longer researches or treatises or collections of laboratory studies which it is important to publish promptly and as units. The price of single numbers varies according to their size. The Monographs appear at irregular intervals and are gathered into volumes of about 500 pages.

Philosophical Monographs: a series of treatises more philosophical in character

Library of Genetic Science and Philosophy: a series of bound volumes.

ANNUAL SUBSCRIPTION RATES

Review: $5.00 (Foreign, $5.25). Review and Bulletin: $9.50 (Foreign, $10.00).
Journal: $5.00 (Foreign, $5.25). Review and Journal: $9.00 (Foreign, $9.50).
Bulletin: $5.50 (Foreign, $5.75). Journal and Bulletin: $9.50 (Foreign, $10.00).
Any of above with Index: $1.50 additional.
Review, Bulletin, and Journal: $14.00 (Foreign, $14.75).
Review, Bulletin, Journal and Index: $15.00 (Foreign $15.75).
Current Numbers: Review or Journal, $1.00; Bulletin, 60c; Index, $2.00.
Psychological Monographs: $6.00 per volume (Foreign $6.30).
Current Issues: prices vary according to size.

Subscriptions, orders, and business communications may be sent direct to the

PSYCHOLOGICAL REVIEW COMPANY
ALBANY, N. Y., and PRINCETON, N. J.

Foreign Agents: G. E. STECHERT & CO., London (2 Star Yard, Carey St., W.C.) Paris (16, rue de Condé)

Vol. 21, No. 11 November, 1924

THE
PSYCHOLOGICAL BULLETIN

RECENT ACOUSTIC RESEARCH[1]

BY CHRISTIAN A. RUCKMICK
State University of Iowa

Greater tribute can scarcely be paid a man than to continue after his death work in the field of his labors. In the last quinquennium since the death of W. C. Sabine his own workshop in the Jefferson Laboratory at Harvard University has been turning out solutions to problems in acoustic research; in his honor Colonel Fabyan has named one of the best equipped acoustic laboratories in the country, at "Riverbank," Geneva, Ill., where Sabine's nephew is investigating acoustic problems; and in scores of universities and industrial laboratories men are taking a renewed interest in auditory phenomena. The technique of the audion tube, used as a detector and amplifier of radio signals, has also done much to revive an interest in acoustics because it furnishes a means of measuring sound values and because it in turns raises new issues and problems. Altogether it is hardly possible to gauge the extent of acoustic research in all branches of scientific endeavor during the last few years, and it is equally difficult to draw the line of demarcation between the several sciences in their output of significant facts.

I propose to give, however, a summary of the important contributions made in the field of acoustics since the death of W. C. Sabine in January, 1919. The date gives me a convenient starting point especially in view of the coincidence that in this year Ogden (71) published the last summary which has appeared on this subject in the BULLETIN. In bringing together the theories and conclusions of

[1] A small portion of this paper has appeared as Architectural Acoustics: Recent Research in America. *Architecture*, 1923, 2, 33–35.

the several sciences I have often found it difficult to group the results separately under each science. There is hardly a problem in the entire field of acoustics which does not have ramifications in the direction of more than one discipline. Indeed, the seven-fold classification which follows, itself disregards a certain amount of interlocking of problems and results. The fact is that modern investigations are becoming more and more coöperative. The architect, the physicist, the psychologist, the physiologist, the philologist, the mathematician, and the musician, all contribute problems and furnish solutions, one to another, in the realm of acoustics.

The Qualitative Aspect of Sound. Psychologically we are still at a loss in regard to the number and nature of the tonal qualities, but several serious attempts have been made to clear up the situation. The terms used to designate these qualities vary in significance from writer to writer. While the Ebbinghaus-Titchener octahedron for the visual qualities has found wide acceptance, the Titchener "tonal pencil," whose length represents change in pitch and whose width indicates change in diffusion or "volume," has not enjoyed equal favor. Watt in Great Britain has recently offered us a valuable contribution on this subject. On the basis of Watt's discussion, together with some of his own investigations and experimental data supplied by Rich, Ogden (72) proposes a tonal manifold which comprises the attributes of pitch-brightness, volume, and intensity. The shape of this manifold tempts one to the remark that Ogden has knocked tones "into a cocked hat." The flattened rim or base line extends to 228 "just noticeable" steps of volume, equal to quarter-tone musical intervals, the height indicates inherent intensity in steps of sensitivity measured in units of the logarithm of ten, and the ridge, thrust to the right and flattened, illustrates the salience of the pitch-brightnesses. Tones pass to vowel sounds when out of the complex pitch-effect a fixed region of resonance is obtained for an appropriate partial tone for each of the vowels; vowels and tones pass to noises when the component tones no longer hold together in a single uniform tonal impression. Rich (77) gives us an excellent historical summary of the work done on tonal attributes and then offers the conclusion, based on extended experimental results with trained observers and carefully controlled interference tubes and variators, that there are only three tonal attributes, pitch, volume, and tonality. The last refers to the musical qualities, such as "c-ness," "d-ness," "e-ness," *etc.* Vocality, or the vowel sound of tones, does not occur at regular intervals as Köhler claims, is not attributive in character, but is a

meaningful perception. The "vowel" significance of the perception comes from the previous linguistic experiences of the individual observer. Under certain social conditions these experiences are for the most part common to a group of observers.

In spite of these negative findings of Rich, the vowel character of tones is still keenly discussed in the scientific literature. Gatewood (26) tested nearly 200 children of an average age of thirteen years, using tuning forks of 256, 512, 1,024, and 1,280 cycles, besides a number of violin and piano tones. Her instructions suggested thirteen groups of possible vowel sounds and required the observers to note what vowel the tone resembled. Judgments of Ū predominate at the lower end and Ī at the upper end, while Ō, in keeping with Köhler's results, ranged about 512 cycles. It must be observed, however, that her instructions directly suggested the vowels. She also finds some sanction for the "mellowness-shrillness" attribute of Meyer. Rich remarks that such results, therefore, signify nothing more than speech habits of the observers. Weiss's work (110) is more extensive than Gatewood's in that more forks were used and teachers of the deaf, who pay particular attention to the sound of vowels in speech training, as well as college students, were investigated. The results agree with those of Gatewood. Weiss defines vocality as "that attribute of auditory sensation which is described by the vowel and semi-vowel character of tones and noises," and he identifies it with the "mellowness-shrillness" attribute of Meyer. On the positive side Lachmund (53) continued the work of Jaensch with rotating sectors and the selenium cell, and found that (1) a pure wave maintained at a certain average cycle, but not regular enough to be identified in pitch, can still be recognized as giving out a vowel character; (2) the particular vowel is dependent on the average cycle maintained; and (3) another tone of lower pitch may become the "carrier" of this formant-like vowel-tone. Liddell (54a) has investigated in the interest of philology some of the finer distinctions of vowel emphasis as when one speaks in a moderate and even voice the two "a" sounds in "*a*ll *a*lters." He is enjoying the coöperation of the research division of the American Telegraph and Telephone Company and is using special telephone receivers with exceedingly small "free period" of membranic vibration, the current thus generated and amplified operating an oscillagraph. The records are then analyzed by Fourier's theorem. Differences are thus detected that are not audible in normal consciousness. Stumpf (96) comes upon the problem of vocality from another angle when he attempts

to distinguish singing and speaking. He finds no phenomenological difference. There is a graded attentive and affective emphasis from one extreme to the other: in speech there are indefinite pitches and variable intervals, in singing attention centers about precise pitches and specific intervals. Interjections are intermediate departures from the one as recitatives are from the other. The situation is much like that of tone and noise. The vowel character may be attributive in a mental sense, as are pitch and intensity when tones are functionally accepted through attention and feeling; but it is not content. On the whole, Stumpf argues against Köhler, who would make speech devoid of pitch-quality in an absolute sense. Several experimenters have recently been at work to determine the characteristics of tonal experiences from a naïve point of view. Smith among them (90) had his observers describe tones of weak intensity. They soon fell to calling one group of tones "aggressive" and another "diaphanous." There was a strong urge to brush the former away and the latter seemed distant. Some analogy existed to lighter and heavier colors. In a second series further discrimination showed that in graded order from strong to weak the tones were called "thrusting," "definite," "very diaphanous," "sound, but not heard," "something—sound?—present." In the last instance tactile sensations—even temperature sensations—were noted. Like the positive experience of blackness, less pronounced sounds gave a real consciousness of silence.

Merry (59) has been engaged in analyzing speech from phonographic records with a device that mechanically amplifies the lateral wave of the record by means of levers. He checked over some of his results with direct connection to the Seashore tonoscope which, through the stroboscopic principle, enables the observer to read pitch variations directly from a rotating drum. Extreme pitch variations, sometimes well over an octave in extent, are thus recorded in ordinary speech. Fletcher (19) removed the fundamental and the first few overtones of richly complex tones as sung by bass, baritone, and contralto voices, and was surprised to find that the pitch of the sung vowels remained unchanged. He therefore concludes that the physical criterion which determines the pitch of complex clangs lies in the difference in the frequencies of the upper partials. In P. E. Sabine's work (83) we find again the suggestion that in sung vowels, at least those which Miller put into the first class because they have only a single region of resonance, the overtone system is somewhat independent of the fundamental. "Ah" had a predominating overtone

at 870 cycles, "aw" at 460 cycles, "ō" at 410 cycles, and "ōō" at 330 cycles, varying very little with a change in pitch of the fundamental, though shifting slightly with changes of intensity. Scripture (86) has been making some new studies of sung vowel tones which have aroused the criticism of Raman and de Wesendonk. His analyses reveal the fact that the vowel tones are independent of the pitch of the voice which as a mechanism acts like a strongly damped resonator with the addition of puffs. The relationship of this breath expulsion to the pitch and intensity of sung tones is receiving careful scrutiny in some unpublished work by Sheldon and Stanley. Schoen (85) has used the tonoscope method with phonographic records of celebrated singers rendering the same musical selection, and has discovered interesting variations of the vibrato, of the attack, of the maintained intonations, and of kindred factors in artistic singing. The large industrial concerns that produce these records are deeply interested in research of this type, many of them maintaining laboratories of their own at which physicists and psychologists are working out solutions to similar problems.

At the same time physicists are scrutinizing the quality of sound from their point of view. The character of the sound wave, for example, is still under investigation. Dutcher (14) reports success with the Foley (24) method of photographing a double and simultaneously produced spark separated by a known distance, but he modifies the method by enclosing the spark in a soap bubble. He finds, however, that the character of the spark, *i.e.*, whether it be "fat" or "lean," modifies the form of the wave. Miller, (62, 63) at the Sandy Hook proving grounds, undertook to study the form of the wave front, together with the velocity, of sounds of great intensity. With a portable phonodeik he was able to photograph sounds from 6-inch, 12-inch and 14-inch rifles at distances from 100 feet to 3,000 feet in front and behind. He states that no true vibratory wave was evident. Two sources were traced, at the station 3,000 feet in front and 700 feet away from the direct path: the crack of the projectile traveling at the rate of 2,600 feet per second, followed by a boom from the muzzle traveling about 1,100 feet per second. In general the form of the wave-front is a circle with a moving center, whose velocity depends on the size of the gun, the amount and character of the charge, and the temperature, humidity, and movement of the air. Grondahl (32) has developed a new method for mapping sound waves and for investigating their transmission under a variety of conditions. He has tried this method out on the human body with

good results. Essentially it consists of a telephone transmitter attached to the mouth of the body with a microphone of special design brought in place over lungs and trachea. The current generated in the microphone is then led through a transformer and two stages of vacuum-tube amplification to the brushes of a crown commutator. Starting with the brushes set at zero reading on a galvanometer, the amount of current generated can then be easily read off.

Bishop (9) has analyzed almost four thousand observations obtained under ideal technical conditions to discover whether auditory sensations are followed by an after-image similar to that found in some other sense departments, notably in vision. He had some difficulty in eliminating the physical "tailing down" of tones, but did so in all of the accepted series which then showed no evidence of subjective after-images. An important monograph has been added to the literature on absolute pitch consciousness—the tendency on the part of some individuals to name correctly the pitch of the sounds they hear. Gough (29) finds that contrary to many statements on the subject steady improvement in this ability can take place with lasting effect. It is commonly claimed that the ability rests largely on an hereditary disposition, and that if those who are not thus adapted attempt the learning of tones by their pitch designations, they make relatively little progress and soon lose the ability. Pratt (75) has made a careful introspective analysis of the qualitative aspects of bitonal fusions. The descriptive terms used were: smoothness-roughness, simplicity, complexity, and pleasantness-unpleasantness. The first meant "without observed variations in intensity"; the second, "unanalyzability"; the third, "recognizable intricacy"; and the last, "involving meaning." This is a laudable attempt to describe the complex effects of harmony on a phenomenological plane. Combinational tones, or tones produced by two other tones, are also receiving their share of attention. Gough and Robison (31) have been able to register both difference-tones, with vibrations equal to the difference of the vibrations of the generating tones, and summation-tones, equal to the sum of the generating tones, on the modified Seashore tonoscope. Gough (30) raises the question, however, whether this summation tone is not produced by a strong second partial together with the fundamental, being in reality a difference tone. Young (112) has given specifications for a set of tunable bars which give very clear difference tones for purposes of demonstration and research. In opposition to the work of Lorenz, Pratt (76) comes to the conclusion that the bisection of tonal intervals falls nearer the

geometrical than the arithmetical mean. He used the method of equal sense-distances and intervals of the musical perfect fifth, the slightly increased perfect fourth, and the slightly increased minor seventh within the total range of 285–510 cycles. He considers the judgments to be too complex to permit the calculation of any logarithmic relation between sensation and stimulus.

Important contributions are being made on the sensitivity of the human ear. Here particularly we see both the influence of highly refined technique developed in radio apparatus and circuits, but also the interest of the telephone industries. Fletcher and Wegel (**21**) have published some very illuminating maps showing individual variations among seventy-two normal ears tested out with special receivers that can be fitted into the opening of the external meatus and which give a range of sound from 30 to 4,000 cycles. Both minimal and maximal intensities of sound were tried. The cutaneous sensations were noted also; the lower range of intensity gave rise to sensations of flutter, the middle range to those of tickle, and the higher range to those of pain. Zuehl (114) has also tested out a number of ears for pitch discrimination and has come to the conclusion that, while there are no significant sex differences, there are variations with age especially with tones above 4,000 cycles, the greatest variation occurring in the region above 7,500 cycles. The range of the human voice (80–1,024 cycles) showed fewer variations than any other region. In criticism of the Seashore phonograph records for testing pitch discrimination, Gilliland and Jensen (**28**) find that for purely scientific research they are not reliable. The scratching of the needle and the complex character of the stimuli affect acute observation. With a clever device that utilizes the eight standard test forks actuated by piano-action hammers they tested forty-three observers and recorded higher scores with the pure forks. The average score was 83.0 per cent correct for the forks; 75.1 per cent correct with the records. There were a total of 757 errors with the records and 510 errors with the forks. As they themselves admit, higher scores and fewer errors are not proofs positive of better tests, as, indeed, most teachers would agree; nor can we overlook the advantages gained through portable and standardized tests rated by comparative rank. The authors claim, however, that the errors show a more equable distribution in regard to the difficulty of the respective series.

The Quantitative Aspect of Sound. Much of the work done on auditory pitch discrimination is correlated with intensive differences of sound, *i.e.*, with auditory acuity. We shall therefore continue the

discussion under the heading of the quantitative aspect of sound. Fletcher and Wegel (21) show some promising audiograms obtained from ninety-three normal ears and a smaller number of abnormal ones. The technique was developed out of the audion circuit with condenser-transmitter and thermal receiver. For very low notes the normal ear requires a sound pressure of about .001 dyne per square centimeter, the slightly deaf ear requires .1 dyne, the partially deaf 1.0 dyne, and the " ear trumpet " type requires 10 dynes. A thousand dynes of pressure gives rise to the sensation of pain in the normal ear. Knudson (49) has developed a ratio of increment of energy to the total energy which gives an average value of sensitivity with his type of apparatus of .18 for ordinary frequencies, and is nearly independent of frequency in the range of 100 to 4,000 cycles in all normal ears. In some cases, however, both the increase in frequency and the increase in intensity tend to decrease the ratio of sensitivity. Kranz (50) on the other hand points out the great divergence of results in this field. In extended later investigations (51) he continues to find great variation in sensitivity between observers, between ears of the same observer, and between tones of different pitch. In general, his results with the thermophone receiver show less sensitivity than do Wien's data. Kranz proposes as a unit of sensitivity the ergs per square centimeter per second expressed as the reciprocal of the logarithm to the base 10 which induce threshold audibility. Thus he finds the average sensitivity of thirty normal ears to be $10^{-7.2}$ for 360 cycles and $10^{-8.6}$ ergs/cm.^{2}/sec. for 1,300 cycles and above, or expressed in his proposed units simply 7.2 and 8.6. The threshold decreases with pitch. Acuity almost doubles in these units within the range of a few octaves as shown by still later results (52) which gave a value of 5 for 128 cycles and 8.5 for 512–4,096 cycles. According to Kranz, an adequate auditory theory to cover these results would have to allow (1) for a large number of elements each concerned with only a small range of frequencies, (2) situated either in the inner ear, in the nerve fiber to the brain, in the brain, or in all three, and (3) including the possibility of having individual elements severely injured without affecting neighboring ones. Minton and Wilson (69) caution investigators against calculating pressure values in telephone receivers and favor methods that determine the pressure acting on the tympanic membrane, especially in view of the fact that the external meatus becomes itself a resonator, with perhaps some elasticity, when closed with the telephonic receiver. These investigators corroborate Kranz's results with

respect to the wide variations expressed in observers and over the pitch range, but they find several points of greater sensitivity: at 500, 3,000, and above 5,000 cycles, although they partially disqualify the last point because the receiver has a natural period in this region. Guernsey,(**33**) on the other hand, by a different method finds that the greatest sensitivity lies in the region of 3,000 to 4,000 cycles, where on the average 100 gradations of intensity can be detected with a single pitch. The Weber-Fechner law appeared to be valid only for the middle range of intensities. Minton and Sonnenschein (**68**) show that the intensity of tones depends to a large extent on the size of the room in which the tones are produced. Such studies point to the advisability of finding the acoustic constants of rooms where experiments involve sources of sound that are not in the immediate vicinity of the observer's ear. The results of these two investigators might bear, for example, on the data obtained by Möller,(**70**) who dropped a ball from six different heights on five differently pitched cylinders, especially if his experiments were to be repeated in a room differing in size from his own. He found that the psychophysical functions for pitch and intensity were constant for the same observer and followed a relatively simple formula which contained a variable but definite factor for each observer. P. E. Sabine (**83**) in his acoustically tested room determined the power of a variety of sound sources by combining the Kranz method of threshold sensitivity with the method favored by the late W. C. Sabine (**84**) of determining the duration of sound after the stimulus had ceased sounding at the source. The fundamental of the violincello strongly bowed varied from 1,000 ergs/sec. at 128 cycles to 10 ergs/sec. at 650 cycles. A good violin gives out 600 ergs/sec. for tones from 192 to 1,300 cycles, while a poor violin shows greatly reduced amounts. Organ pipes, and masculine and feminine voices were also tested out. Sabine used a thermophone receiver containing a platinum strip .00216 mm. thick and heated with a one-ampere current at six frequencies ranging in octaves from 128 to 4,096 cycles passing through a circuit of vacuum tube oscillators. Harmonics were eliminated by electrical filters. Eight ears showed a variation in the audibility of minimal sound to the extent of a hundred thousandfold. The smallest energy heard was 10,000 times that found by Wien and equalled 2.2×10^{-8} ergs per sq. cm. per sec. MacKenzie (**58**) also used the thermophone and found that out of 180 comparisons 93 cases gave logarithmic results in accordance with the Weber-Fechner law of just noticeable differences. He gives a diagram of an " alternation phonometer "

circuit which he believes to be superior to the "flicker phonometer" method and apparatus patented by Heck, because the "tailing down" of sound is too short (.002 sec.) for the flicker method. This assumption is in keeping with the negative results of Bishop (9) in connection with the after-image effect referred to above. The "alternation phonometer" allows two tones of different frequency to be balanced for equality of loudness. A range of ten to one in acoustic pressure was noted in ten women and ten men with greatest differences at the threshold, but without any marked sex difference. Bunch (11) describes in detail the Iowa pitch range audiometer which Zuehl also used and which appears to be particularly adapted for a variety of conditions underlying auditory acuity. Zuehl was particularly successful in diagnosing auditory defects in the external, middle, and internal regions of the ear. Karcher (45) believes that his device, which is an improvement of the Pierce telephone receiver and contains a crystal detector and galvanometer in circuit, has advantages over the Rayleigh disc resonator and the Webster (104) phonometer in that it permits of ready change of frequency. He discusses a method of computing acoustic pressures from the vector sum of their components. Barus (2, 3, 6) and Weaver (103) also contribute to this discussion on the side of mathematical and physical theory. Foley (24) details the photographic method already mentioned under his name. In an enclosed box two sparks are produced across gaps, with the first slightly retarded by a condenser. The light furnished by this spark must pass through the path of the second spark and its accompanying sound disturbance and across the irregularly cut teeth of a rotating wheel before it reaches the photographic dry plate. The speed of the wheel is a known quantity. The apparatus is well suited to the calculation of the velocity of sound and to the detection of wave disturbances.

Theory of Audition. Although the Young-Helmholtz theory of audition has enjoyed wide acceptance with such modifications as the sponsors themselves would probably have made in the light of modern research, it is receiving vigorous attacks just now from several quarters. Two psychologists (10) go even so far as to say, "The Helmholtz theory of audition, in spite of Ebbinghaus' gallant effort to save it, seems to have sunk beyond recovery." Dahns in Germany revives the Rutherford telephonic-membrane theory with his claim that the tympanic membrane reflexly tunes itself in response to external stimuli. Roaf accepts the analyzing function of the basilar membrane but couples with it the adjusting mechanism of the scalae

walls in response to variations of sound pressure. Wrightson in England applies a lymph pressure system to the whole of the cochlea and Wilkinson emphasizes the neglected point of the increasing weight of the basilar fibers from base to apex in any resonance theory.

The Wrightson theory has been critically reviewed by Boring and Titchener,(10) who attack it on both mathematical and physical grounds. They appreciate, however, the kinematic analyses of the ear that preceded the formulation of the theory and the resultant new facts brought forth. Hartridge (40) objects to it more specifically for mathematical reasons. He shows that Wrightson's formulae make it possible for all time intervals within certain broad limits to act on the pulse system of the inner ear with equal effect, affording thus no discrimination between them. After giving a comprehensive historical and critical review of the modifications and possibilities of the resonance theory, Wätzmann (102) comes to its defense with the statement that its summary dismissal is not to be considered. In the light of new observations the resonance hypothesis will still stand adaptation. With similar purpose Hartridge (39) made additional investigations with blocked holes in a siren disc which gave recognition of brief interruptions. He concludes that a short silence is mentally equivalent to a short noise, and explains the occurrence by assuming, in analogy to a physical apparatus with which he worked, that the basilar fibers and organs of Corti in the neighborhood of the silent area are slightly agitated. When full allowance is made for the difference in tension, mass, and length of each fiber in the basilar membrane, he believes that the resonance theory is still the only one entirely adequate to explain most of the phenomena of audition, including those that correspond to a reversal in the phase of the sound wave. Furthermore, E. Meyer (60) has observed an attraction and repulsion effect of resonators on phase changes. When the exciting tone is lower than that of the resonator, the wave is reflexly attracted; when higher, it is repelled. These phenomena are called "ponderomotor" effects and have been previously studied by Dvorak and Lebedew. Meyer analyzed them into "resonance force" and "wave force" and determined the unsymmetrical relationship between them. Their dependence on pitch and amplitude has also been studied. Application of these facts shows that the notion of a resonating membrane in the ear is not untenable even if the membrane does not vibrate as freely as is sometimes desired. Wegel and Lane,(109) however, raise questions in connection with the masking effect of one tone on another that are not yet satis-

factorily answered by a resonance theory. Pure tones of nearly equal pitch, but differing enough to avoid beats, have the greatest masking effect. Loud tones mask tones higher than themselves better than they mask tones lower in pitch than themselves. These facts seem to be explained more adequately by some dynamical theory that involves the movement of a considerable portion of the basilar membrane for each tonal sensation. More details are found in Fletcher's experiments (20) with the use of a thermal receiver that records not only the frequency but, by means of absorption of acoustic energy, also the intensity of the stimulus. This receiver together with its appropriate circuits he calls an audiometer. One hundred normal ears were tested. Taking into account his own results and Knudson's data, (49) he concludes that the normal ear can hear about 300,000 different pure tones. All variations of pitch and intensity were produced over a considerable range and on this basis a pitch and intensity scale was drawn up. In this connection the Weber-Fechner law was verified both in regard to the *j.n.d.* for pitch as related to intensity and also for the reverse relation. Minton (67) has thrown a side light on the masking effect of tones by studying tinnitus, the subjective "ringing in the ear," in this connection. There was a marked decrease in sensitivity for the range of frequencies of these subjective tones when tested in the usual manner, showing a positive masking of objective tone by subjective tone. Minton presupposes, however, that the disturbance can best be explained by a disturbance in the auditory nerve, which accords with his own theory of audition. The masking effect was carefully studied with results similar to those of Wegel and Lane. If a composite tone, containing a pure tone of 400 cycles at 50 units of intensity, one of 300 cycles at 10 units, and one of 200 cycles at 10 units, be sounded to a normal ear, only the first and the last are heard. An increase of 30 intensive units throughout would eliminate the last instead of the second tone. Above the upper limit of hearing the ear still responds, not as an auditory but as a tactile receptor. Hearing passes on to touch of the variety of tickle. All told, these facts lend themselves more readily to a membranous theory of audition in which the whole basilar membrane is conceived to vibrate in response to incident sound waves. Even pure tones would not produce an even vibration throughout the membrane, but the region of maximal amplitude would give the pitch and the extent of the amplitude the intensity of the tone. The article concludes with an excellently selected bibliography of ninety-three titles. The well-known Ewald theory, which is of the same

type, is reviewed by Zoth (**113**) with the modification that the wave "picture" be formed on Reissner's membrane instead of on the basilar membrane. The hair cells could still be excited by standing waves operating perhaps through the tectorial membrane.

But the most serious criticism of the Helmholtz theory comes from Minton,(**64, 65, 66**) whose experiments prove to his satisfaction and apparently to the satisfaction of many physicians and physiologists that any theory which is primarily based on mechanisms within the inner ear or cochlea is untenable. The evidence is of two sorts: (1) A patient whose cochlea had been removed and another whose cochlea had been destroyed by disease could both hear all tones up to 5,000 cycles, and (2) in cases of extreme deafness tones break through as noise whenever they are made extremely loud—about 665,000 times as much current as normally was passed through the receiver—because there is not sufficient nerve energy present to conduct the disturbance as tone to the brain. Minton asserts, then, that the cochlea, like all other sense-organs, acts to lower the threshold of hearing, but that the nerve ends are themselves selective and are therefore finally responsible for tonal analysis. In other words, the nerve-endings can act in a reduced capacity without the cochlea. He has also worked out a number of charts showing auditory sensitivity in normal and abnormal subjects in support of his theory, and he finds that there are three distinct maxima of sensitivity up to 6,000 cycles with the greatest sensitivity in the region of 200 to 4,500 cycles, *viz.*, at 900, 1,800, and 3,900 cycles. In the abnormal subjects he has reason to believe that exposed nerve-endings will themselves react to a very narrow band of frequencies, and would therefore function selectively. We need further corroboration of this important work. In any event we must rest satisfied that all theories will have to be modified to accommodate themselves to a reduced upper limit of tonal hearing. Pratt,(**74**) following some German researches, thinks that this limit is below 20,000 cycles—specifically, in his experiments with steel cylinders, at 18,610 cycles. The Galton whistle formerly much in use in this field of study has recently been recalibrated, as noted by Ruckmick,(**79**) so that its highest tone is almost an octave lower, or about 25,000 cycles. Wegel (**108**) has mapped out the modification of sounds produced by the external passages of the ear, and finds the technique of the telephonic research laboratory highly satisfactory in the investigation of defective hearing as well as in devising new methods of aiding individuals thus afflicted.

Sound Localization. During and since the World War the prob-

lems involving the localization of sound in a variety of media have again appeared in the forefront of investigation. One of the subjects of investigation is the "phantom sound." Seashore (88) among others undertook this subject as a war problem in order to study "the danger of finding more than one apparently correct location" of a given sound. Open air investigation proved to be more conducive to good results than experiments conducted within confined areas where sounds had to be led to the ear through tubes. If, for example, the observer moves between two telephonic receivers connected in parallel and facing each other at a distance of two meters, he will hear a "phantom sound" moving at each quarter wave distance in a direction opposite to its previous apparent motion. This phenomenon definitely points to the problem of localization. In the words of Seashore: "Does the ear have a localization mechanism for wave-phase as such, or is the wave-phase localization reducible to the binaural intensity principle?" Halverson (34) at first developed the position that the movement of the sound was not so much due to phase disturbances as it was due to differences in intensity at these points. He worked with both stationary receivers and moving observers and with the reverse conditions. Records of intensive changes were made both introspectively and by means of the audiometer. In a later study (35) he shows that if localization occurs toward the side of leading phase difference median localizations should show greater volume than lateral ones because of greater coöperation in the former case. When observers were used who had become practised in recognizing changes of volume, the results showed that the lateral tone at 90° was declared to be equal to the median tone at 900 cycles but of lesser volume at intermediate angular settings. While he took every precaution against subjective confusions of pitch, intensity, and volume, he is not certain that the last two were eliminated.

Von Hornbostel (43) has recently published some independent research in which Halverson's results were practically duplicated. Carsten, Hecht, and Salinger (12, 41) have also verified the phantom sound using both air and water as a medium. At the normal incidence of 3° difference for the two ears, the difference in velocity of sound reaching the two ears would have to be 3×10^{-5}, whereas the threshold of distinction is 12×10^{-4}. They conclude that sound is localized by phase differences in the region of 400 to 800 cycles, and above that point either by intensive differences or by differences in time of first excitation. Watt (101) also takes a somewhat modified

stand when he states that the intensity factor gives the definite right and left orientation but not the particular direction. Lachmund (54) and Flügel (22) have tried to compensate fatigued or adapted ears by noting the amount of distortion in localization that fatigue produces in one or the other ear. Flügel used an "adapter" which brought the localization to the median point by elongating one or the other of two flexible pathways, thus slightly changing the phase. One tube was then entirely shut off and the tone admitted for some time to the other ear. After it had been thereby fatigued, both tubes again brought the tone to the respective ears with the result that the fatigued ear heard it more weakly than the rested ear, thus throwing off the localization. While the argument does not seem to the reviewer free from error because all adjustments of the instrument to offset the effect of fatigue were complicated by unanalyzed resultant changes in phase as well as in intensity, the experimenter concludes that localization did not take place solely on a basis of intensive changes and certainly not on conscious appreciation of intensive factors. The fatigue effect itself was independent of pitch and intensive variation of tones within the range used, 256 to 512 cycles. A good summary of the recent literature on the subject of sound localization can be found in Ogden's new book,(73) which, indeed, presents readable reviews of many other specific problems in acoustics but which on that account deserves a separate critique.

Hartley and Fry (36, 37, 38) question the importance of phase difference in binaural localization of tones and indicate that in all experiments in which the tones are separately led to the two ears the factor of distance is lacking. There are normally three cues to localization: the vertical angle, the horizontal angle, and the distance. In proportion as the tonal mass that is to be localized becomes complex in nature, the more easily is it localized. The mathematics of combination then shows that whereas a group of three tones has but one chance, ten tones have 120 chances of correct localization. In the localization of pure stationary tones there are four factors: amplitude (loudness), average phase, difference in amplitude (binaural ratio), and difference in phase. It is to be noted, however, that when two tones of different frequency were led separately to the two ears with adjustable lengths of tubing, the setting of the tubing gave one tone to one side, the other to the other, and an indistinct chord of both in the median plane with a tendency to be localized toward the lower-toned ear. This was noticeably true with forks giving 256 and 512 cycles simultaneously to the two ears, but with

256 and 384 cycles in combination the lower tone was completely eradicated. Attention is called to a somewhat similar phenomenon with submarine localization where a noise element remained and refused to be united with the mass of sound. In conclusion Hartley and Fry have analyzed three steps in the localizing process: resolution of sound into constituent tones, independent physiological location of each separate component, and the formation of the final conscious judgment.

In definite opposition to any theory which stipulates that sound localization depends on the ratio of intensive differences in the sounds as they come to the two ears, Stewart (**91, 94**) presents evidence from his own elaborate research. He states that in practically all cases intensity plays no rôle in the region of 1,000 to 2,000 cycles and concludes that there is a direct perception of phase-difference. This sets anew the problem of an auditory theory which shall account for the direct recognition of differences in the form of the sound wave on the basis of the structure and function of the mechanisms in the ear. Stewart slightly modifies an extreme position on this point when he admits that his work applies to pure tones and to tones within the limits of his assumed phase sensitivity. He has already indicated that there were individual variations from the mathematical expression of his logarithmic law. With impure tonal complexes changes in intensity admittedly produce qualitative changes in the clang which could be used as cues for localization. Simpson (**89**) worked within the region explored originally by Stewart and Hovda where the logarithmic law of binaural intensity was found to apply, *viz.*, 128 to 512. Stewart and Hovda had shown that there were individual variations in the law at this point and that its value decreased with increasing frequency in the tone. Simpson agrees with some of the later results of Stewart when he discovers that the angular displacement of the "phantom sound" is a function of its frequency, and that there are individual differences in his own investigations. Ruckmick (**78**) worked with apparatus which kept the phase of the sound wave of a pure tone exactly the same for the two ears. The observers were furthermore kept in ignorance of the physical conditions. The illusion of a single source of sound was increased by the instruction to report its distance from the observer as well as its location. The tones used were 193, 200, and 217.5 cycles and the apertures (glass tubes) which led the tones to the two ears were changed to give intensive differences in the binaural ratios. Localization depended, then, on intensive differences alone and were correct within

the usual margin of error and with the extreme values for the inserted glass tubes. The writer has recently found that if a click occurs at the end of a tone from a telephone receiver, it is frequently given a markedly different location from that of the tone. He has also checked over the two methods of localization, by giving angular displacements from a visualized chart and by pointing in the direction of the supposed location of the source of sound and has found a superiority in accuracy in the latter method. Clearly with all these conflicting and tentative results much still needs to be done in this field. It is a work which manifestly invites the coöperation of the several sciences concerned in it.

Acoustic Properties of Confined Spaces. Since the establishment of the acoustic laboratory at Riverbank, Illinois, much effort has been directed by P. E. Sabine toward the analysis of the reflecting and absorbing qualities of the chambers within which research is being pursued. At the same time refinement in technique and apparatus is proceeding apace. Sabine (**81**) has tested out certain types of hair-felt within the entire range of ordinary musical tones. He finds that the logarithm of the reduction in the intensity of transmitted sound is proportional to the thickness of the material through which it passes. It is a linear function of the order of the fourth root of the frequency. At 4,096 cycles, however, the reduction was less than this, and it also approaches a limiting value as layers are increased in thickness. In general, reduction of sound transmission follows closely the reduction in the stream of air through the material. He also finds (**80**) that with plaster walls much absorption is due to the dissipating effect of the pores of the material at the surface of incidence. This effect is increased with the frequency of the sound and with the ageing of the material, and is decreased with the amount of humidity in the air. With a tone of 4,096 cycles there was a decrease of 25 per cent in dissipation with an increase of .45 to .85 in humidity. In another investigation W. C. Sabine (**84**) had determined the transmission of sound through various media, chiefly hair-felt and sheet iron, of standard thicknesses. On the whole, sheet iron transmitted less sound, layer for layer, than hair-felt, but alternate layers of each transmitted the least. P. E. Sabine, using a similar technique, confirms the belief that rigidity of material is an important factor in the reduction of transmitted sound. Plate glass 3/16 inch in thickness is more effective than two 1/16-inch plates of glass with 1/16 inch layer of celluloid between them. Even dead air-spaces or spaces filled with material for heat-insulation, as in refrigerator doors,

are not as good "sound-proofing" materials as solid walls of iron or oak. In other experiments he has given minute data on the transmission of sound through flexible material, including asbestos and sea-weed. Watson (99) also gives carefully supervised results in regard to the transmission, absorption, and reflection of sound waves in materials that readily set up vibrations themselves because they are not rigid enough. This was further developed in testing out various materials used for sound-proofing. For instance, plaster with a large percentage of gypsum in it was more effective because it is more rigid than ordinary plaster. Barus has explored surfaces of a room and its contents with a U-gauge of special design the acoustic change in pressure of which can be read off on the principle of the ordinary interferometer. He has written several articles (4, 7) indicating the usefulness of this type of device for measuring sound reflections from objects and walls of a room. Fountain (25) reports interesting acoustic improvements of a large municipal auditorium at Macon, Georgia. The building was a temporary wooden construction on a permanent steel framework and measured 200 ft. x 130 ft. x 60 ft., with an air capacity of about 47,000 cubic meters. The acoustic properties of the auditorium were so poor that a speaker on the platform could not be heard even faintly at the center of the hall. Sabine's reverberation formula for that type and size of construction should have given a value of 13 seconds with an empty hall and 3.5 seconds with an audience of 2,500 persons, but there was actually no reverberation, due probably to the fact that the surface of the boards was unfinished, that the boards themselves were thin, and that there were numerous cracks. The roof probably also reflected the sound out through the open spaces planned for ventilation. Curtains on the stage, muslin on the rear walls, and wires strung through the hall did not improve matters. An inner stage was constructed with plaster on wooden lath for its walls. Conditions were thereby so improved that a pin dropped anywhere on the stage except at the corners could be generally heard throughout the hall. As Lyman (57) has recently so appropriately said it is not so much a matter of lack of acoustic information that accounts for architectural failures of this sort, but rather the lack of coöperation between architects and professional experts in acoustics, especially on the physical side of the question. This statement is significant, in that it comes from the director of the Jefferson Physical Laboratory at Harvard University, where, it will be remembered, W. C. Sabine did so much of his epoch-making work. The more important papers and addresses of Sabine in which he

describes his method of improving the acoustic properties of several halls at Harvard are now available in book form.(84) The way in which his highly theoretical knowledge was combined with skilled architectural practice in the production of one of the most satisfactory music halls in the country—and one situated in the heart of city traffic—is interestingly revealed in this book, while analogies are drawn from other concert halls abroad. European acoustical problems are critically reviewed by Michel (61) and many opportunities are indicated for the application of well-known scientific facts. Happily there are now many instances in this country which show that this coöperation is a *fait accompli.* One of the largest corporations engaged in constructional work widely advertises its " acoustic treatment " of many college, municipal, and private assembly halls and at several of our universities there is excellent coöperation between the architectural and acoustic experts.

Analysis of Acoustical Apparatus. Allied to the foregoing types of research is the work that is going forward in connection with many different forms of acoustic apparatus and the problems that these forms present. The layman would probably be astonished at the fact that even with such simple instruments as horns and organ pipes many problems still remain unsolved. Foley,(23) for example, maintains that Rayleigh's theory contradicts itself and that the hypothesis of a concentration of sound waves in the axial direction of a horn or ear-trumpet is untenable. Horns are exclusively neither condensers nor resonators but partake of the characteristics of both. Photography of emitted sound by the spark method shows that condensation at the small end is relatively slight. Flares with end-values of 7.8 to 256 in ratio gave 3 to 20 per cent less amplification than would be expected from a simple condenser theory. Sound pulses do not glide around corners and curves but are reflected; in fact, much of the energy entering wide angle horns from the wide end may be reflected to the source. In crooked tubes the waves may emerge at different phases. These results were checked over by means of the Rayleigh disc resonator and the Webster phonometer, but either method gave only relative values. On the other hand, Cloud (13) states that in his experiments a horn 50 centimeters long and with a 6° flare did act as a resonator for organ tones in a room padded with one-inch hair-felt. He agrees with Foley in finding that there was no concentration of energy in front of the horn, although the intensity of sound was doubled in the room and increased by one-half in the open air. He believes that the Webster

disc phonometer with the suspending wire under tension is as sensitive as the human ear but that it has a resonance value equal to its natural frequency. The Rayleigh disc measures absolute energy directly. Stewart (92) finds that a conical horn used as a receiver gave amplification for all frequencies higher than the frequency of fundamental resonance. There is an optimal angle for each series of overtones. The angle increases with the frequency and decreases with the order of the overtone. Organ pipes and reed instruments have also received attention. Just what happens at the lip of an organ pipe when it is blown is still uncertain; likewise the reason for the change in pitch of blown instruments when the pressure is changed. Bhargasa and Ghosh (8) show that experimental data for the physical phenomena at the mouth of an organ pipe are wanting. They supply some significant quantitative results obtained by the use of the phonodeik which show the precise relationship between pitch and pressure. Lunn (56) assumes that there is a kinetic stiffness of the air jet at the lip which must be counterbalanced by a discontinuity in the pressure which in turn accelerates or diminishes the frequency of the sound wave when the pressure is increased or decreased. The effect of pressure on pitch has been indirectly studied by Love and Dawson.(55) Working with Stern variators and organ pipes connected to a water manometer, they discovered by means of a Rayleigh resonator that the intensity of sound varied directly with the pressure and that pitch rose with pressure, requiring larger volumes of the resonator. Jones (44) shows how complicated the pitch system of reed pipes becomes by virtue of the addition of the reed tone to that of the resonance chamber of the pipe. He distinguishes an "edge tone" produced by the air jet striking the upper lip. When this is near the pitch of the pipe the greatest divergence in effect occurs. Taylor (97) has also studied the "broken tone" from the bassoon and has photographed the tone produced by opening the vent normal to *d* of 145 cycles while *F* of 87 cycles is sounding. The result was a *B* flat of 116 cycles, an *f* of 174 cycles, and a difference tone *BB* flat of 58 cycles. He has analyzed the tones from bells but finds a wide practice in the tuning of chimes especially between English and continental tuners. In India, Ghosh tells us,(27) there are kettle-drums which are used to accompany stringed instruments and which produce overtones in a harmonic series. The center of the drum-head is loaded with variable weights and, by changing the load, different series of overtones are produced, including the various odd series. Barus (15) has done patient work in connection with pin-hole apertures connected

with his resonator and interferometer. He finds that a salient conical tube emits no sound while a reëntrant conical tube audibly reproduces a telephonic sound at certain points, dependent on the length of the tube. Both of these tubes are coupled in his plus-minus resonator. Watson (**98**) has devised a double resonator with a short connecting tube containing a Rayleigh disc. He finds that this becomes an acoustic galvanometer with one telephone inserted in an open end of one of the resonators or an acoustic relay with two telephones attached. Its sensitivity is of the order of 10^{-8} amperes. He has also tested out a rectangular megaphone on Rayleigh's theory that if a train of parallel waves pass through a slit whose width is equal to or smaller than half the wave length, they spread out as if from an aperture. In a megaphone made on this principle he has succeeded in spreading out the voice over an angle of at least 90° in a very large armory. The late A. G. Webster (**104**) has recommended the application of the electrical term "impedance" to acoustics and mechanics and has discussed the use of such formulae to the action of horns of all types and of the trombone. A heavy plaster-paris casting of a trombone horn gave values no different from those of the usual brass trombone. He has also mentioned (**104**) the use of a 3 mm. glass tube or "antenna" for the exploration of standing waves produced by his standard phone in horns.

For investigating these phenomena Webster (**104**) used his phonometer which he has described in detail. It is as sensitive as the human ear but only for a limited range of pitch values and is constructed on the principle of two adjustable resonators which affect a torsional mirror that reflects an incandescent filament. The reading is taken through a micrometer-microscope. In its more recent form (**107**) several improvements have been made. It is portable and the diaphragm, which is one of the resonance units, is tuned by changing the tension of three supporting wires. It operates on the principle of the Michelson interferometer. The sound of unknown character is compared with the effect of a standard fork in terms of the interference "rings." Webster estimated on the basis of this instrument that an average speaker's voice has a pressure equal to a few millionth parts of atmospheric pressure and that ten million cornets played fortissimo would produce only one horse-power of sound. Edwards (**17**) has suggested an adaptation of the resonator principle to pitch discrimination. He gives details concerning a battery of tuned resonators with light torsional vibrators on which are mounted concave mirrors reflecting light upon a screen. The reso-

nators are tuned at one-eighth musical intervals and could be used, like the Seashore tonoscope, for testing the maintained pitch of singers. King (47) has investigated the output of energy of fog-horn apparatus by calculating the difference in the amount of heat on the low pressure and the high pressure sides of the diaphone; in other words, by translating sound values into heat values and the reverse. He claims that the overtones are more and more eliminated with distance and that the fundamental is alone to be heard at a distance of three miles. This reminds one of Stumpf's statement concerning the "boom" of the drum which is the sole survivor of a band concert at a distance. Knipp (48) has been engaged at the task of finding a satisfactory theory for the "singing tube" which he accidentally discovered. An inclosed inverted tube heated over an annular burner was found to emit a tone that is practically pure at a pitch dependent among other things upon the length of the tube attached at the side of the specially constructed device.

Stewart (93) has described a series of filters which give fairly pure tones from 90 to 1,500 cycles and up to 5,000 cycles. They apparently meet both physical and mathematical requirements and absorb or dissipate sound energy in the same manner as does an automobile muffler or a Maxim gun silencer. Recently (95) he has succeeded in reducing the wave band of broad filters by changing the size of the orifice which then lowers the upper range of emitted sound while the lower limit remains constant. Wilson (111) has done work with the pressures observed in diaphragms immersed for sound detection in water and suggests the maximum dimensions for these direction-finders. Two such receivers are generally in use to provide for the binaural effect. At this writing a report is also at hand that the sonic rangefinder developed by the Navy Department is being used in discovering by reflection of sound under water the presence of icebergs in foggy weather, as well as in "sounding" the depth of water.

Hewlett (42) has perfected a non-magnetic diaphragm between two sets of flat coils with an alternating current superimposed on a direct current. This receiver then has the virtue of lacking the overtones that arise when iron is used in the diaphragm and when the magnetic field is non-radial. It can be used both as a generator and as a receiver and gives practically pure tones from 500 to 25,000 cycles. King (46) and others have been interested in discovering the peculiarities of telephonic receivers, and Eckhardt (15) finds in the specially modified oscillator and amplifier that partial vibrations

may be considerably reduced by cupping the diaphragm. The latter has also mapped out (16) the sound field of a parabolic mirror nine feet in diameter and three feet in focal length. Several interesting circuits are outlined by Ferguson (18) through which a tuning fork is operated with the smallest possible variation in frequency. The control of the fork depends upon the oscillations of an audion tube with a synchronous motor and chronograph in parallel circuits. Anderson (1) has discovered a method of eliminating the disturbing first overtone in forks of less than 256 cycles in frequency. If the tine is lightly struck at the internal node one-fifth of its length from the top and at the same time firmly held at a point two-fifths of its length from the bottom, a much purer effect will be obtained.

P. E. Sabine (82) has tested out a number of devices for the amplification of hearing in the partially deaf. He finds that the telephonic devices are the most satisfactory, since their natural period of vibration coincides in general with the average pitch range of hearing.

Musical Talent. Only a small portion of this very interesting field properly comes within the present scope of our review, since the work goes beyond the auditory field to cover every phase of the musical consciousness. Seashore's volume (87) embodies many standardized tests of auditory capacity and has had a wide influence in musical circles. It gives a scientific account of the musical mind and contains diagrams of acoustic apparatus and the procedures for using them in the testing of musical talent. Seashore's pupils have gone forth to explore this fertile field and several of them are doing very significant work. Schoen, for example, at the Carnegie Institute of Technology, has recently published some detailed analyses of musical ability which show a high correlation with the ratings of pupils by their teachers. Five of the tests of musical talent have been reproduced on phonographic records and have been received with much favor by schools of music and private teachers.

A very valuable work has appeared under the title, *The Foundations of Music,* by Watt,(100) in which the experimental and theoretical contributions of psychology are brought under their musical captions. Beats, combination tones, overtones, and interval relationship are fully discussed. The psychological analysis underlying the prohibition of consecutive fifths and other intervals and chords, the interpretation of hidden octaves, the distinction between consonance and concordance, and the entire treatment of melody, which the author ingeniously calls "paraphony," is well carried out and more

easily followed than some of the author's previous writings on similar subjects. Bingham's work on melody apparently finds no place, however, in the author's thinking.

This review, highly condensed and in some respects technical, may nevertheless afford a sort of bird's eye view of an extensive field of scientific endeavor in this country. In many instances, even with this superficial outline of the work, it can be seen how minutely inter-allied the problems are. Even such definitely applied bits of knowledge as the acoustic properties of auditoriums depend in their analysis on the facts gleaned from curved surfaces represented to us in such distantly related objects as conical horns, musical instruments, and booming guns. All of these and many other cases lead to further knowledge of the behavior of the sound wave. But equally important, of course, is the advance in knowledge of the normal and abnormal human ear in its psychological and physiological aspects. What we distinctly lack and what we most certainly need at this stage of our acoustic development is a better diffusion of knowledge through the channels of specialized journals and mutual association. A convention of men interested in these problems and engaged in their solution would be a preliminary step in this desired direction. The papers read at such a convention would form a very useful and respectable volume and would lead to the other prerequisites of closer coöperation.

References

1. Anderson, S. H. Overtones of Large Tuning Forks. *Phys. Rev.*, 1923, **21**, 692–694.
2. Barus, C. Acoustic Pressure Distributions, Chiefly in Reservoirs and in Pipes. *Proc. Natl. Acad. Sci.*, 1921, **7**, 207–213.
3. ———. Plane Reflection of Sound as Exhibited by the Pin-Hole Resonator. *Ibid.*, 1922, **8**, 66–69.
4. ———. Acoustic Topography Varying with the Position of the Organ Pipe. *Ibid.*, 96–100.
5. ———. Positive and Negative Pin-Hole Resonators. *Ibid.*, 163–165.
6. ———. Acoustic Pressure and Acoustic Dilation. *Science*, 1921, **53**, 489–494.
7. ———. Acoustic Topography in a Room. *Ibid.*, 1922, **55**, 321–326.
8. Bhargasa, S., and Ghosh, R. N. Note on Over-Blown Pipes. *Phys. Rev.*, 1922, **20**, 452–455.
9. Bishop, H. G. The Experimental Investigation of the Positive After-Image in Audition. *Amer. J. of Psychol.*, 1921, **32**, 305–325.
10. Boring, E. G., and Titchener, E. B. Sir Thomas Wrightson's Theory of Hearing. *Amer. J. of Psychol.*, 1920, **31**, 101–113.

11. BUNCH, C. C. Measurement of Acuity of Hearing Throughout the Tonal Range. *Psychol. Mono.*, 1922, **31**, No. 1, 45–82.
12. CARSTEN, H., and SALINGER, H. Zur Frage der Lokalisation von Schallquellen. *Naturwissensch.*, 1922, **10**, 329–330.
13. CLOUD, J. H. Effect of Conical Horns on the Sound from an Organ Pipe. *Phys. Rev.*, 1923, **22**, 73–77.
14. DUTCHER, J. B. A Photographic Study of Explosions in Gases. *Phys. Rev.*, 1920, **15**, 228–229.
15. ECKHARDT, E. A. A Portable Sound Producer of Considerable Range as to Frequency and Intensity. *Phys. Rev.*, 1921, **17**, 380.
16. ———. The Sound Field of a Parabolic Mirror. *Ibid.*, 381.
17. EDWARDS, P. A Simple Apparatus for Testing Pitch Control. *Phys. Rev.*, 1921, **18**, 120–121.
18. FERGUSON, J. G. A Clock-Controlled Tuning Fork as a Source of Constant Frequency. *Bell Syst. Tech. J.*, 1923, **3**, 145–157.
19. FLETCHER, H. What Is the Physical Criterion which Determines the Pitch of a Musical Tone. *Phys. Rev.*, 1923, **21**, 706–707.
20. ———. Physical Measurements of Audition and Their Bearing on the Theory of Hearing. *Bell Sys. Tech. J.*, 1923, **2**, 145–180.
21. FLETCHER, H., and WEGEL, R. L. The Frequency Sensitivity of Normal Ears. *Proc. Natl. Acad. Sci.*, 1922, **8**, 5–6; *Phys. Rev.*, 1922, **19**, 553–565.
22. FLÜGEL, J. C. On Local Fatigue in the Auditory System. *Brit. J. of Psychol.*, 1920, **11**, 105–134.
23. FOLEY, A. L. A Photographic Study of Sound Pulses Between Curved Walls and Sound Amplification by Horns. *Phys. Rev.*, 1920, **15**, 229; 1922, **20**, 505–512.
24. ———. A Photographic Method of Finding the Instantaneous Velocity of Sound Waves at Points Near the Source. *Proc. Natl. Acad. Sci.*, 1920, **6**, 310–312.
25. FOUNTAIN, C. R. The Acoustics of Large Auditoriums. *Phys. Rev.*, 1921, **17**, 385–386.
26. GATEWOOD, E. L. The Velocity of Fork, Violin and Piano Tones. *Amer. J. of Psychol.*, 1920, **31**, 194–203.
27. GHOSH, R. N. Note on Musical Drums. *Phys. Rev.*, 1922, **20**, 526–527.
28. GILLILAND, A. R., and JENSEN, C. R. The Reliability of the Seashore Record for the Measurement of Pitch Discrimination. *J. of Exp. Psychol.*, 1922, **5**, 214–222.
29. GOUGH, E. The Effects of Practice on Judgments of Absolute Pitch. *Arch. of Psychol.*, 1920, **7**, No. 47, 1–93.
30. ———. Combination Tones Registered by the Tonoscope. *Amer. J. of Psychol.*, 1921, **32**, 159–160.
31. GOUGH, E., and ROBISON, G. The Tonoscope as a Means for Registering Combination Tones. *Amer. J. of Psychol.*, 1920, **31**, 91–93.
32. GRONDAHL, L. O. A Method of Studying Sound Waves by Means of a Synchronous Commutator. *Phys. Rev.*, 1921, **17**, 258–259.
33. GUERNSEY, M. A Study of Liminal Sound Intensities and the Application of Weber's Law to Tones of Different Pitch. *Amer. J. of Psychol.*, 1922, **33**, 554–569.

34. HALVERSON, H. M. Diotic Tonal Volumes as a Function of Difference of Phase. *Amer. J. of Psychol.*, 1922, **33**, 526–534.

35. ———. The Rôle of Intensity in Auditory Wave Phase. *Psychol. Mono.*, 1922, **31**, No. 1, 7–29.

36. HARTLEY, R. V. L. Function of Phase Difference in Binaural Localization of Pure Tones. *Phys. Rev.*, 1919, **13**, 373–385.

37. HARTLEY, R. V. L., and FRY, T. C. The Binaural Location of Pure Tones. *Phys. Rev.*, 1921, **18**, 431–442.

38. ———. The Binaural Location of Complex Sounds. *Bell Sys. Tech. J.*, 1922, **1**, 33–42.

39. HARTRIDGE, H. A Vindication of the Resonance Hypothesis of Audition. *Brit. J. of Psychol.*, 1920, **11**, 277–288; 1921, **12**, 142–146; 1923, **14**, 362–382.

40. ———. A Criticism of Wrightson's Hypothesis of Audition. *Ibid.*, 1921, **12**, 248–252.

41. HECHT, H. Ueber die Lokalisation von Schallquellen. *Naturwissensch.*, 1922, **10**, 107–113.

42. HEWLETT, C. W. A New Tone Generator. *Phys. Rev.*, 1922, **19**, 52–60.

43. HORNBOSTEL, E. M., v. Beobachtungen über ein- und zweiohriges Hören. *Psychol. Forsch.*, 1923, **4**, 64–114.

44. JONES, A. T. The Organ Pipe as a Coupled System. *Phys. Rev.*, 1921, **18**, 118–120.

45. KARCHER, J. C. Apparatus for Measuring Sound Intensity. *Phys. Rev.*, 1921, **17**, 382.

46. KING, L. V. On the Determination of the Electrical and Acoustic Characteristics of Telephone Receivers. *J. of Frank. Inst.*, 1919, **187**, 611–624.

47. ———. On the Measurement of the Acoustic Output and Efficiency of Fog Alarm Apparatus. *Phys. Rev.*, 1921, **18**, 120.

48. KNIPP, C. T. Note on the Characteristics of the New Singing Tube. *Phys. Rev.*, 1921, **17**, 532–534.

49. KNUDSON, V. O. Sensibility of the Ear to Small Differences in Intensity and Frequency. *Phys. Rev.*, 1922, **19**, 261.

50. KRANZ, F. W. Minimum Sound Energy for Audition. *Phys. Rev.*, 1921, **17**, 384.

51. ———. Minimum Intensity for Audition. *Ibid.*, 1923, **21**, 573–584.

52. ———. The Sensitivity of the Ear as a Function of Pitch. *Ibid.*, 1923, **22**, 66–72.

53. LACHMUND, H. Vokal und Ton. *Zeits. f. Psychol.*, 1922, **88**, 1–52.

54. ———. Ueber die Abhängigkeit der scheinbaren Schallstärke von der subjective Lokalisation der Schallquelle. *Ibid.*, 53–55.

54a. LIDDELL, M. H. The Physical Characteristics of Speech Sound. *Bull. Purdue Univ.*, No. 16, **8**, 1924, 1–55.

55. LOVE, B. F., and DAWSON, M. K. The Variation in Sound Intensity of Resonators and Organ Pipes with Blowing Pressure. *Phys. Rev.*, 1919, **14**, 49–53.

56. LUNN, A. C. The Influence of Blowing Pressure on Pitch of Organ Pipes. *Phys. Rev.*, 1920, **15**, 228, 446–449.

57. LYMAN, T. Acoustical Research. *Science*, 1922, **56**, 633–634.
58. MACKENZIE, D. The Relative Sensitivity of the Ear at Different Levels of Loudness. *Proc. Natl. Acad. Sci.*, 1922, **8**, 188–191; *Phys. Rev.*, 1922, **20**, 331–348.
59. MERRY, G. N. Voice Inflection in Speech. *Psychol. Mono.*, 1922, **31**, No. 1, 205–229.
60. MEYER, E. Ponderomotorische Wirkungen von Tonwellen auf resonierende Membranen. *Ann. d. Physik*, 1923, **71**, 567–590.
61. MICHEL, E. Ueber Hörsamkeitsstudien. *Naturwissensch.*, 1922, **10**, 420–423.
62. MILLER, D. C. A Photographic Study of the Wave Form of Sounds from Large Guns. *Phys. Rev.*, 1920, **15**, 230.
63. ———. On the Propagation of the Sound Wave from the Muzzle of a Large Gun. *Ibid.*, 1921, **17**, 255–257.
64. MINTON, J. P. Some Physical Characteristics of the Ear. *Proc. Natl. Acad. Sci.*, 1921, **7**, 221–225.
65. ———. Some Cases of Nerve-Deafness and Their Bearing on Resonance Theories of Audition. *Ibid.*, 1922, **8**, 274–280.
66. ———. Physical Characteristics of Normal and Abnormal Ears. *Phys. Rev.*, 1922, **19**, 80–96.
67. ———. Tinnitus and Its Relation to Nerve Deafness with an Application to the Masking Effect of Pure Tones. *Ibid.*, 1923, **22**, 506–509.
68. MINTON, J. P., and SONNENSCHEIN, R. Eine Untersuchung über die Schallverstärkung mittels des Schaefer'schen Resonatoren Apparatus. *Beitr. z. Anat., Physiol., & C.*, 1923, **19**, 147–162.
69. MINTON, J. P., and WILSON, J. G. Correlation Between Physical and Medical Findings on Normal Ears. *Proc. Natl. Acad. Sci.*, 1923, **9**, 269–274.
70. MÖLLER, E. F. The Effect of Change of Intensity Upon the Upper Limit of Hearing. *Amer. J. of Psychol.*, 1922, **33**, 570–577.
71. OGDEN, R. M. Hearing. *Psychol. Bull.*, 1919, **16**, 142–148.
72. ———. The Tonal Manifold. *Psychol. Rev.*, 1920, **27**, 136–146.
73. ———. *Hearing*, N. Y., 1924.
74. PRATT, C. C. Highest Audible Tones from Steel Cylinders. *Amer. J. of Psychol.*, 1920, **31**, 403–406.
75. ———. Some Qualitative Aspects of Bitonal Complexes. *Ibid.*, 1921, **32**, 490–515.
76. ———. Bisection of Tonal Intervals Smaller than an Octave. *J. of Exper. Psychol.*, 1923, **6**, 211–222.
77. RICH, G. J. A Note on "Vocality." *Amer. J. of Psychol.*, 1921, **32**, 446–447.
78. RUCKMICK, C. A. Experiments in Sound Localization. *Psychol. Mono.*, 1921, **30**, No. 3, 77–83.
79. ———. Calibration of the Galton Whistle. *Amer. J. of Psychol.*, 1923, **34**, 278–281.
80. SABINE, P. E. Effect of Humidity on Sound Absorption by Plaster Walls. *Phys. Rev.*, 1921, **17**, 379.

81. ———. Transmission and Absorption of Sound by a Porous Material. *Ibid.*, 378–379.
82. ———. The Efficiency of Artificial Aids to Hearing. *Ibid.*, 1922, 19, 262.
83. ———. Acoustical Power of Certain Sound Sources in Absolute Units. *Phys. Rev.*, 1923, **22**, 303–312.
84. SABINE, W. C. *Collected Papers on Acoustics.* Cambridge, 1922.
85. SCHOEN, M. An Experimental Study of the Pitch Factor in Artistic Singing. *Psychol. Mono.*, 1922, **31**, No. 1, 230–259.
86. SCRIPTURE, E. W. Nature of Vowel Sounds. *Nature*, 1921, **106**, 632–634, 664–666; 1921, **107**, 12, 332.
87. SEASHORE, C. E. *The Psychology of Musical Talent.* New York, 1919.
88. ———. Wave Phase in the Open-Air Localization of Sound. *Psychol. Mono.*, 1922, **31**, No. 1, 1–6.
89. SIMPSON, M. Experiments in Binaural Phase Difference Effect with Pure Tones. *Phys. Rev.*, 1920, **15**, 421–424.
90. SMITH, E. M., and BARTLETT, F. C. On Listening to Sounds of Weak Intensity. *Brit. J. of Psychol.*, 1920, **10**, 133–168.
91. STEWART, G. W. The Function of Intensity and Phase in the Binaural Location of Pure Tones. *Phys. Rev.*, 1920, **15**, 425–431, 432–445; *Proc. Natl. Acad. Sci.*, 1920, **6**, 166–169.
92. ———. The Performance of Conical Horns. *Phys. Rev.*, 1920, **15**, 229–230.
93. ———. Acoustic Wave Filters. *Phys. Rev.*, 1922, **20**, 528–551.
94. ———. The Intensity Logarithmic Law and the Difference of Phase Effect in Binaural Audition. *Psychol. Mono.*, 1922, **31**, No. 1, 30–44.
95. ———. A Variable Single Band Acoustic Wave Filter. *Phys. Rev.*, 1923, **22**, 502–505.
96. STUMPF, C. Singen und Sprechen. *Zeit. f. Psychol.*, 1924, **94**, 1–37.
97. TAYLOR, J. B. Broken Tone from Reed Instrument. *Phys. Rev.*, 1921, **17**, 534–535.
98. WATSON, F. R. The Acoustical Double Resonator, and Its Application. *Phys. Rev.*, 1921, **17**, 380.
99. ———. *Acoustics of Buildings.* New York, 1923.
100. WATT, H. J. *The Foundations of Music.* Cambridge, England, 1919.
101. ———. A Theory of Binaural Hearing. *Brit. J. of Psychol.*, 1920, **11**, 163–171.
102. WÄTZMANN, E. Die Resonanztheorie des Hörens; ihre Entwicklung und ihr gegenwärtiger Stand. *Naturwissensch.*, 1922, **10**, 542–551.
103. WEAVER, W. The Pressure of Sound. *Phys. Rev.*, 1920, **15**, 399.
104. WEBSTER, A. G. A Complete Apparatus for Absolute Acoustical Measurements. *Proc. Natl. Acad. Sci.*, 1919, **6**, 173–179.
105. ———. Acoustical Impedance and the Theory of Horns and of the Phonograph. *Ibid.*, 275–282.
106. ———. Experiments on the Vibration of Air in Conical Horns. *Ibid.*, 1920, **6**, 316–320.
107. ———. Absolute Measurements of Sound. *Science*, 1923, **58**, 149–152.

108. WEGEL, R. L. The Physical Characteristic of Audition and Dynamical Analysis of the External Ear. *Bell Sys. Tech. J.*, 1922, 1, 56–68.

109. WEGEL, R. L., and LANE, C. E. The Auditory Masking of One Pure Tone by Another and Its Relation to the Dynamics of the Inner Ear. *Phys. Rev.*, 1923, 21, 705–706.

110. WEISS, A. P. The Vowel Character of Fork Tones. *Amer. J. of Psychol.*, 1920, 31, 166–193.

111. WILSON, H. A. Theory of Receivers for Sound in Water. *Phys. Rev.*, 1920, 15, 178–205.

112. YOUNG, P. T. Series of Difference Tones Obtained from Tunable Bars. *Amer. J. of Psychol.*, 1922, 33, 385–393.

113. ZOTH, O. Ueber eine Modifikation der Ewaldschen Hörhypothese. *Zeit. f. Sinnesphysiol.*, 1923, 55, 179–184.

114. ZUEHL, B. F. Measurement of Auditory Acuity with the Iowa Pitch Range Audiometer. *Psychol. Mono.*, 1922, 31, No. 1, 83–101.

GRAPHIC FUNCTIONS

BY JUNE E. DOWNEY
University of Wyoming

Graphology. Of the pseudo-sciences of character-reading, graphology is to-day probably the most popular. The carefully planned test of the powers of Rafael Schermann, the Viennese "psycho-graphologist," executed and reported by MacAdam for the New York *Times,* is a refreshing exception to the usual exploitation of graphology in newspapers. It would, indeed, be profitable to test out some well-known graphologists who have a flair for interpretation of handwriting, but unfortunately many of them are averse to working under controlled conditions. French's book (**9**) gives a great deal of interesting material in the shape of copious illustrations arranged under definite rubrics. It does not appear difficult to read character from holographs when the writers of them are men famous or infamous. French claims that his readings have, however, penetrated many a secret. In hope of finding such a revelation the reviewer turned eagerly to the characterization of certain cabinet members who have been in the limelight recently but without profit. It is needless to say that the title of this book, "The Psychology of Handwriting," is misleading. Douglas,(**4**) an amateur graphologist, who advocates the use of an impressionistic method in contrast to an analytic one, bases his conclusions largely on the study of the signature, in the writing of which he believes much more self-feeling enters than is true for other writing. Many of the observations upon which he depends are those of conventional graphology. Douglas reports that he gets extraordinarily accurate visual images of penmen from study of their signatures although he does not know how it can be possible to deduce physical appearance from the signature.

Joire's treatise on graphology (**15**) is a delightfully lucid presentation of the generally accepted principles of graphology. Particularly interesting are the chapters on the autograph, the paraphe, and on familial resemblance in handwriting.

Crépieux-Jamin (**3**) presents a valuable account of certain experiments of his own to demonstrate the extraordinary degree to which even the simplest graphic mark such as the numeral 1 registers

individuality. He shows, too, how the presence of self-feeling modifies motor expression; the changes that occur in writing when, for example, I is used as a personal pronoun instead of as a mere phonetic symbol. The book contains many valuable plates.

A delightful passage from Havelock Ellis (5) embodies his belief that deep-rooted idiosyncrasy as well as family nervous habit may deflect the child's patient efforts to imitate the model set before him. He writes further: "It has been noted of the ancient and distinguished family of the Tyrrells that their handwriting in the parish books of Stownmarket remained the same throughout many generations. I have noticed, in a relation of my own, peculiarities of handwriting identical with those of an ancestor two generations ago whose writing he certainly never saw."

Lemanski (20) canvasses the varieties of pathological handwriting as determined by sensori-motor and psycho-motor disturbances, or by cortical or spinal cord lesions. In particular he views the work of Duparchy-Jeannez concerning the possibility of using various graphic signs as symptomatic in the diagnosis of organic diseases, such as those of the stomach, liver, heart, gastro-intestinal disease, and the like, and raises the question whether such graphic disturbances may be attributed to disturbances of cortical reflexes through the association of the latter with splanchnic reflexes. He cites experiences in his own medical practice where he found that trembling of the tongue in attacks of marsh fever was apt to be associated with irregularities in alignment in writing. Neurasthenia, megalomania, and melancholia are also cited as presenting graphic symptoms. The author commends study of handwriting as an aid in the study of biographies from the medical angle and reproduces and comments on the handwriting of Mirabeau. On the whole, he believes medical graphology deserves serious consideration.

Moeller (28) also emphasizes the value to physicians of a study of handwriting. He urges the need of obtaining samples of the handwriting of the patient before the onset of a disease and during its progress and the value of comparing handwriting samples from patients suffering with the same disease. In the case of sudden changes appearing in the writing of an individual, they should be subjected to a careful scrutiny, for such graphic symptoms as falling alignment, spasmodic and irregular pressure, and blurring of forms. Changes are said to appear in the handwriting of patients who are growing deaf, and facsimiles of Beethoven's writing are cited in proof of this statement. Paralysis shows itself in writing not only

in the omission or repetition of letters or words, but also by changes in the writing itself. Purely organic diseases are less easily diagnosed from writing than mental diseases since here the influence is an indirect one through the mood of the patient. However, excitement and a rapid pulse introduce sudden changes in pressure. "Zitterscrift" appears in excitement, old age, and among drug habitues.

Sternberg (36) presents a most thoughtful analysis of the kinds of movements employed in writing. In general, he classifies movements into staccato and legato ones, and develops some interesting consequences from recognition of this difference. He also calls attention to the fact that the same sort of classification holds for the movements of both speech and writing.

Mühl (29, 30) demonstrates that automatic writing is "not only an indicator of an unstable mental background, but also of some of the fundamental factors which help to make up the personality," and gives some valuable suggestions concerning different sorts of automatic writing and hints concerning the best way to initiate automatic writing. She cites a most interesting case of automatic mirror-writing and one of the freeing of literary talent by means of automatic writing. A notable statement from the present standpoint is her assertion that radical changes occur in the individuality of hands with the assumption of different personalities. Many specific instances of this sort are cited. Reproduction of such material would be of immense value in the study of handwriting, and the reviewer wishes to record here an appeal for publication of samples of such changes in conjunction, of course, with samples of the natural writing. Mühl writes: "In looking over my numerous records and observing the graphic characteristics I found that by attempting to interpret the script itself according to the tables in Downey's book on graphology, and then comparing the results with my analytical material, that there was a remarkable coincidence of findings in determining the emotional state for periods of the unconscious revealed through the writing."

Melcher (26) also asserts the possibility of radical changes in handwriting individuality in the case of dual personalities, which, apparently, he considers very common occurrences. Haggard (13) illustrates her article on "A Case of Somnambulism" with a reproduction of handwriting produced in a sleep state. Unfortunately, only one word in the normal writing is given for purposes of comparison.

Handwriting Identification. Schneickert (34) summarizes the now well recognized difficulties that the handwriting expert faces in

attempting to identify disputed documents. Only the individual who is aware of the really characteristic features of his handwriting can produce a disguise that is hard to penetrate. Imitations of alien hands are not common except in the case of signatures; only a virtuoso can suppress the characteristic features of his own hand and assume those of another. Schneickert also suggests (33) a simplication in the methods of classification and of indexing the handwriting of criminals.

Langenbruch (18) describes a mathematically exact system for identification of handwriting by measurement of the relative proportions which result from a penman's feeling for space relations and his possession of a characteristic rhythm. So-called "Rhythmuslinien" are measured. Hellwig (14) appraises the Langenbruch system of graphometry by an analysis of its value in actual court work. His judgment concerning it is conservative since a subjective element is involved in the choice of basal points for taking the essential measurements.

Melcher (26) states that marked effects rarely follow from a voluntary attempt at disguise, especially with respect to those graphic details of the importance of which the penman is ignorant. In the case of duplex personalities it is a different matter. Here changes in the individuality of the writing enter and only a close examination by an expert reveals discriminating marks.

Osborn's "The Problem of Proof" (31) draws much of its illustrative material from disputed document trials. Besides emphasizing many points made by the author in his great book on "Questioned Documents," it gives many new suggestions to the handwriting expert.

The Development of Handwriting. The teaching of handwriting, Freeman (8) asserts, is dominated by the dogma that the so-called arm-movement is a superior method of writing, a dogma which is completely refuted by scientific evidence. Pupils in the main never acquire an arm movement. By photographing the movements of the hand and arm by a kinetoscopic camera and studying motion pictures, Freeman has been able to analyze the movements of good writers and of bad writers. West,(39) defining rhythmic movement in writing as a "tendency to give succeeding strokes the same time emphasis," finds that an imposed rhythm is an aid in early years only. Rhythm and quality of writing are lowered when a writer with a habituated rhythm attempts to follow a beat.

Beatty (1) reports a comparative study of the Thorndike, Ayres,

and Starch Scales for measuring quality of handwriting and cites as his conclusion that the Ayres Scale (Gettysburg Edition) is to be preferred for general use on grounds of convenience, reliability, and all-around practicality. He presents data that show a critical weakness in the Thorndike Handwriting Scale.

To measure handwriting Gilchrist (11) finds nothing more needed than a stop-watch for timing writing and a standard reader to be timed in reading the specimen produced. He gives direction for obtaining an accurate index of handwriting ability.

A plan for adapting the shorthand alphabet to printing is presented by Larue.(19) Larue gives the results of an experiment in teaching children to read matter printed in this form, and points out the tremendous advantages that would result from its general use.

Thurnwald (37) gives a copiously illustrated résumé of the development of written language through picture-writing, rebus-writing, and ideograms, to phonetic and cursive writing. The part played by simplification and conventionalizing of forms, and by symbolization, is portrayed and the motivation of the process by religious and magical beliefs outlined. In the same volume, Giese (10) sketches the characteristic features of the child's writing as distinguished from that of the adult, relying for this outline largely upon the Kraepelinian investigations.

Trögel (38) not only outlines the development of written language from primitive beginnings, but also follows this development through historic times. He describes briefly the various forms of writing implement that have been in use and the various materials on which the writing record has been made, and shows how such customs have left their imprint upon words we use to-day. From "stylus," for example, comes our "style" and also "stiletto."

An interesting study of the effect upon Japanese psychology of the use of ideograms instead of phonetic writing is made by McKim (25). One obvious effect has been to develop a visualistic turn in the Japanese. For them handwriting is a fine art. "For just as Europeans tend to auralize what they read, the children of the ideogram visualize what they hear." Sentimental and social reasons for retention of the ideogram are canvassed, but the author believes that it should and will gradually give place to a phonetic system of writing.

Mirror-Writing. The literature on mirror-writing has been reviewed in another connection.[1] A brief résumé is given here.

[1] See in this journal general review on "Right and Left Handedness," 1924.

Joteyko (17) advocates the practice of left-hand mirror-writing by soldiers who have lost their right arms. Pfeifer (30, 31) believes that the difficulty in writing ordinary fashion with the left hand is in part due to inhibitions arising from a tendency to mirror-write instead; in part, it is due to the fact that the writer has no visual picture of how it should appear. If spontaneous mirror-script is to be produced, attention must be distracted from the writing or the eyes closed. Fluent mirror-writing gives no evidence of the inferiority of the right hemisphere in controlling skilled movements. The famous case of Leonardo da Vinci, who during his life had recourse both to left-hand and right-hand mirror-script, is discussed in detail. Liepmann (21) finds nothing new in Pfeifer's explanation of mirror-writing as originating from a symmetrical exercise of the left hand by the training of the right, but does reject vigorously the conclusion that the inferiority of the right hemisphere is in general a consequence of inhibitions arising from the exercise of the opposite hemisphere. Myerson and Quercy (27) find spatial displacements of all sorts in the first attempts of children at writing or drawing, and accept the explanation that spatial relations are not well constituted in the child's early perceptions. Fildes (6) and Fildes and Myers (7) report experiments that also lead to the conclusion that there are causes of wrong orientation other than use of the left hand. Mühl (30) reports an interesting reversion to mirror-writing in the case of an automatic writer.

Psychology of Drawing. Jones (16) has investigated the native powers peculiar to children who have art ability. A questionnaire sent to some 200 artists suggested that their memory is usually conditioned largely by visual impressions and is active in elaboration of sense material. Many artists belong to a motor type; their productions are a resultant of a sensori-motor or visual-motor reaction. There is much associational and discriminative activity. The mind of the artist is logical and not necessarily emotional, although he may appeal to the emotions of others. To test the artistic ability of children it is necessary to list special abilities and to plan a test for each. Two tests are reported on briefly: one for visual memory and one for the threshold of perspectivity. Both were found to correlate with general drawing ability and with each other.

Cohen, (2) examining the assumptions that underlie a scale for measuring ability in drawing, calls attention to the fact that there are two sorts of drawings, namely, transcriptive delineations, which attempt a relatively accurate correspondence between depiction and

the thing depicted, and expressive depiction, in which correspondence to an object is not an essential quality. There are, he insists, not one kind of good drawing but many. Moreover, in teaching drawing to children, our concern is with what the child gets by drawing and not what kind of drawing he produces. The "employment of a scale or any other severely objective standard, because its concern is with the drawing product rather than with processes, is at once inadequate and undesirable."

Luquet has published an historical summary of the methods that have been used in the study of children's drawings,(23) and he has traced (22) the stages in the evolution of drawing in the child, comparing their products with those of paleolithic art. He has also made a study of children's drawings of the human figure in which no representation of the trunk is found.(24) The absence of this part of the human anatomy is frequently an appearance only, since the trunk is really represented by some detail or other. The child attributes slight importance to the trunk, and it appears in the child's drawings only when it seems to the child needed as a place of attachment for the arms.

Goldenweiser (12) considers that the comparison of primitive art to the drawings of childhood is a crude conception and believes it due merely to the apparent helplessness at realistic representations in children's art and in early art. Primitive artists do not face a problem of drawing with a free psychology but in the light of the stylistic conventions of their people. This stylistic factor is found even in the crudest designs.

In his résumé of the characteristic features of the plastic arts as developed by primitive peoples, Thurnwald (37) has occasion to sketch the principles which have motivated the development of drawing. Drawings in sand, cliff and cave drawings, drawings upon utensils, are commented upon, and the significance of purely ornamental designs and of lines and arabesques is discussed. Copious illustrations are given. As regards the similarity between primitive and modern art, Thurnwald states that features which in the former are naïve are in the latter merely a pose. He recognizes the existence of a stylistic element which leaves its imprint upon the drawings produced by a given people.

Giese (10) traces the development of drawing skill in the child, outlining a number of definite epochs in such development, and the characteristic features of different stages. The child's ineptitude at handling space relations and perspective is recognized, and Stern's

conclusions given for the frequency of mirror-drawings by children. A résumé follows of the specific endowments that, taken together, constitute a gift for drawing.

REFERENCES

1. BEATTY, W. W. Judging Handwriting. *J. Educ. Psychol.*, 1922, **13**, 170–172.
2. COHEN, J. The Use of Objective Criteria in the Measure of Drawing Ability. *Ped. Sem.*, 1920, **27**, 137–151.
3. CRÉPIEUX-JAMIN, J. *Les bases fondamentales de la graphologie et de l'expertise en écriture.* Paris: Alcan, 1922. Pp. 51.
4. DOUGLAS, A. W. The Art and Nature of Graphology. *Atlantic Monthly*, 1924.
5. ELLIS, HAVELOCK. *The Dance of Life.* Houghton Mifflin, 1923. Pp. xiv+377.
6. FILDES, L. G. Experiments on the Problem of Mirror-Writing. *Brit. J. Psychol.*, 1923, **14**, 57–67.
7. FILDES, L. G., and MYERS, C. S. Left-Handedness and the Reversal of Letters. *Brit. J. Psychol.*, 1921, **12**, 273–278.
8. FREEMAN, F. N. The Scientific Evidence on the Handwriting Movement. *J. Educ. Psychol.*, 1921, **12**, 253–270.
9. FRENCH, W. L. *The Psychology of Handwriting.* Putnam, 1922. Pp. 226.
10. GIESE, F. Kinderpsychologie. *Kafka Handb. d. Vergleich. Psychol.*, Bd. I, 1922, München.
11. GILCHRIST, E. P. A Handwriting Scale. *Sch. & Soc.*, 1920, **12**, 203–204.
12. GOLDENWEISER, A. A. *Early Civilization.* New York: Knopf, 1922. Pp. 428+xiv.
13. HAGGARD, S. M. A Case of Somnambulism. *Brit. J. Psychol.*, 1921, **11**, 338–339.
14. HELLWIG, A. Die Graphometrie im Straffahren. *Arch. f. Kriminol.*, 1916, **67**, 42–66.
15. JOIRE, P. *Graphologie Scientifique.* Vogot, 1921. Pp. 250+vii.
16. JONES, E. E. The Correlation of Visual Memory and Perception of Perspective with Drawing Ability. *Sch. & Soc.*, 1922, **15**, 174–176.
17. JOTEYKO, P. L'usage de la main gauche chez les mutiles. *Revue scient.*, 1916, 494–499.
18. LANGENBRUCH, W. Die Graphometrie. *Arch. f. Kriminol.*, 1917, **68**, 178–210.
19. LARUE, D. W. The Shorthand Alphabet and the Reforming of Language. *Scient. Mo.*, 1922, **15**, 271–281.
20. LEMANSKI. Les troubles de l'écriture. *Paris méd.*, 1921, 213–221.
21. LIEPMANN, H. Bemerkung zu R. A. Pfeifers Aufsatz; Beobachtungen an Rechts- u. Linkshänder-Schrift von anscheinend weittragender Bedeutung. *Zsch. f. d. ges. Neur. u. Psychiat.*, 1921, **68**, 376–383.
22. LUQUET, G. H. Genèse de l'art figuré. *J. de Psychol.*, 1922, **19**, 695–719, 795–831.

23. LUQUET, G. H. La méthode dans l'étude des dessins d'enfants. *J. de psychol.*, 1922, **19**, 193–221.
24. LUQUET, G. H. Les bonhommes têtards dans le dessin enfantin. *J. de Psychol.*, 1920, **17**, 684–710.
25. MCKIM, J. C. Some Reflections on the Ideogram. *Atl. Mo.*, 1921, **127**, 499–504.
26. MELCHER, W. A. Dual Personality in Handwriting. *J. Crimin. Law & Criminol.*, 1920, **11**, 209–216.
27. MEYERSON, I., and QUERCY, P. L'orientation des signes graphiques chez l'enfant. *J. de Psychol.*, 1920, **17**, 462–476.
28. MOELLER, W. Medizin und Handschrift. *Fortschr. d. Med.*, 1922, **40**, 65–67.
29. MÜHL, A. M. Automatic Writing as an Indicator of the Fundamental Factors Underlying the Personality. *J. Abnor. Psychol. and Soc. Psychol.*, 1922, **17**, 162–183.
30. MÜHL, A. M. The Use of Automatic Writing in Determining Conflicts and Early Childhood Impressions. *J. Abnor. Psychol. and Soc. Psychol.*, 1923, **18**, 1–32.
31. OSBORN, A. S. *The Problem of Proof.* New York: Bender, 1922. Pp. 526+xxi.
32. PFEIFER, R. A. Die rechte Hemispäre und das Handeln. *Zsch. f. d. ges. Neur. u. Psychiat.*, 1922, **77**, 471–508.
33. PFEIFER, R. A. Vorläufige Edwiderung zu Liepmann's Kritik meiner Arbeit; Beobachtungen an Rechts- u. Linkshänder-Schrift u. s. w. *Zsch. f. d. ges. Neur. u. Psychiat.*, 1921, **68**, 416.
34. SCHNEICKERT, H. Die Schwierigkeiten der Schriftvergleichung. *Arch. f. Kriminol.*, 1916, **67**, 263–268.
35. SCHNEICKERT, H. Vereinfachung der Handschriften-Sammlung. *Arch. f. Kriminol.*, 1917, **68**, 142–146.
36. STERNBERG, W. Neue Gesichtspunkte aus der physiol. Muskelmechanik f. die Graphologie u. internationale phonetische Lautschrift. *Fortschr. d. Med.*, 1922, **40**, 35–38, 63–65.
37. THURNWALD, R. Psychologie des Primitiven Menschen. *Kafka Handb. d. Vergleich. Psychol.*, Bd. I, 1922, München.
38. TROEGEL, R. Schreiben u. Schrift. *Neue Bähnen.*, 1922, **33**, 339–346.
39. WEST, P. V. The Relation of Rhythm to the Handwriting Movement. *J. Educ. Psychol.*, 1922, **13**, 438–444.

SPECIAL REVIEWS

PARR, T. *Der Intellektuelle Eigenwert der Gefühlsbetonung.* Ist der Dualismus zwischen Erkenntnis und Gefühl Berechtigt? Kristiana: Jacob Dybwad, 1923. Pp. 125.

This is a second and enlarged edition of a monograph first published in Norwegian in 1912. Comparatively few changes have been made and the author's illness prevented him from taking account of psychological thought since the first edition. Since the monograph is not likely to be widely accessible, this review aims to be of the type which will be a substitute for the text itself.

"The purpose of the work before us," he tells the reader, "is to prove that the feeling life of man contains nothing which is not to be regarded as a more or less *elaborated* part of intelligence (Intelligenzteil), or as a part of the raw material of intelligence" (p. 5).

Taking first the elementary feelings, these are not to be regarded as linked or closely associated with sensations, above all are not attributes of sensation, but are *identical* with sensation. This is not to be confused with the doctrine set forth by Stumpf that pleasure and pain are particular kinds of sensation. All sensations *are* feelings, are the same experience seen from another conceptual or introspective viewpoint—"unter anderer Vorstellungsbegleitung." This it is which justifies us in ascribing to the feelings an *inherent* intellectual worth. It is not that the feelings influence the intellectual processes; they are actually a factor in *constituting* them. The breach between cognition and affection must be closed. The feeling tone of emotions—the specific content—is just as much an indispensable element in the intellectual life as sensations and ideas, and this because the feelings *are* the sensations—or ideas—in their primal immediacy. "The richest intellect is conditioned by the richest feeling-life. Instead of speaking of intellect and feeling, we should speak of the two chief ways in which intellect displays itself: the affective and the relatively indefferent."

In the first place, we must broaden our conception of what a feeling is. The limitation of feeling to pleasure-unpleasure is arbitrary: any marked affectivity of the self is a feeling. It may be hedonically neutral. When the impression or affection is immediate, unlocalized,

not directed towards an object, it seems to be intellectually valueless and is rated a "feeling." Let the impression become more highly conscious and definite, and the experience is called a sensation. A given experience may therefore be looked upon as either feeling or as sensation, but is more naturally called one or the other according to the definiteness of certain "objectifying functions." The organic and cutaneous group of experiences are naturally intermediate, as the very freedom with which they are alternatively called feelings or sensations indicates. In brief, a "feeling" is an unobjectified sensation, a "sensation" is a feeling which is objectified. All experiences are both, since there is an element of objectivity in the most "subjective" experience, and *vice versa*. "The impressions in question present themselves as feelings if one apprehends them as simple subjective 'announcements' (Ichmeldungen), as sensations if one apprehends them as 'announcements' of the external world, as sensations *and* feelings if one apprehends them as both" (p. 89). An experience may be affectively toned and not announce itself—apparently, in introspection—as such.

Such apparent difficulties and anomalies as are not dealt with by means of the foregoing principles are explained by the appeal to a thoroughgoing dualism between the primary reaction and the secondary reaction. This dualism, a temporal one, replaces the qualitative one between cognition and affection. Indeed, Parr would have us bear in mind that in the usual case we have at least the following factors to consider:

(1) The primary sensory experience and its direct and inherent feeling tone.

(2) The more or less indefinite sensory impression which proceeds from the associated organic-motor reaction, and *its* feeling tone.

(3) The almost instantly associated ideas and images with *their* feeling tones.

(4) The organic-motor sensations due to (3) with *their* feeling tones.

In the ordinary, not specifically emotional, reaction these are all fused together in a fusion resisting ordinary analysis. In emotion, the factors under (2) and (4) are prominent. The pleasure or unpleasure which is ordinarily said to "accompany" a sense impression is merely the pleasure-unpleasure aspect of an unlocalized provoked or secondary sensory reaction. The variability of the hedonic tone is due to the difference in this secondary reaction caused by a slight difference in the primary reaction, some unnoticed attendant

circumstance which evokes a quite different organic resonance. Since a great part of the secondary reaction is organic and visceral, and since these are notoriously lacking in objectivity, it is clear that Parr is not far from the theory which identifies feeling with an internal sensory response. The difference lies in the insistence upon such a feeling factor lying, generally unnoticed, in *every* sensation. Yet as regards what are ordinarily called the simple feelings, even in technical discourse, Parr's exposition accords with the visceral sensation theory.

For Parr, however, the importance of the distinction is indicated by the major title, and finds its application in the field of the emotions and higher feelings. These are distinctive modes of consciousness, correlative with those traditionally classed as intellectual. The constituents are in both cases the same, viz., feeling-sensations or sensation-feelings. But the combinations of these constituents are diverse, different aspects of the constituents are emphasized in the two forms of consciousness. We should, however, in view of the identity of the constituent factors, no longer contrast the intellectual with the affective but should speak of the two ways in which intellect manifests itself.

This point, while touched upon with great frequency, is nowhere developed. Instead we have a long discussion of the alleged deficiencies of the emotions for the intellectual life. The emotions are shown to have all of the characteristics, one by one, they need to be judged intellectual, or at least the raw material for intellection. This, we are to understand, is due to the fact that the emotions are made up, not of sensations which are inherently feeling-less, nor of feelings without sensations, but of sensations which are at the same moment feelings.

Throughout, the essential correctness of the James-Lange hypothesis is assumed but the central thesis is said to be independent of the "material versus spiritual" interpretation of emotion. In an appendix, Parr formulates his own suggestions for the revision of the James-Lange theory.

a. The more a given experience is to be reckoned an emotion, the more decisive the rôle of the visceral and kinesthetic sensations.

b. James and Lange have therefore given us a peculiarly valuable approach to the explanation of emotions, but

c. There is no ground to deny the coöperation of all sensations and ideas in emotions, the importance varying with the emotion in question.

The method throughout is the appeal to authorities, chiefly the non-experimental systematizers. For although none has held the thesis as a whole, most of them sustain one or more of its essential contentions. The impression one gets, therefore, is somewhat as if one were reading a doctoral disseration of the 1890's.

Yet such dialectic compilation has its value. One hardly realizes how much of the *framework* of one's systematic psychology is not merely nonexperimental but uncritical. Here we have, for example, a number of characters commonly ascribed to feeling: indefiniteness, dependency, inaccessability to direct or exact recall, etc. Parr calls these and many others into question and in so doing causes one to wonder at one's confidence in such dicta.

The reviewer must confess that he remains unconvinced of the correctness of Parr's thesis, or indeed of its importance if correct. Even though it be true that every experience has its own inherent feeling-tone, that which is almost universally called its feeling character is admitted to be due to some associative reaction. As for the intellectual value of the higher feelings, no one, it seems to me, denies that. But again it is admitted or rather insisted in a separate chapter that these higher feelings constitute a separate sort of conscious formations which really do contrast with the formations which are properly called "intellectual." Finally it seems apparent that if Parr's suggested differentiation of feeling and sensation on the basis of the objectification of the latter is correct—and this has been more clearly suggested before—then the identification of feeling and sensation really breaks down. What we have is the assertion of two factors present in all experience, more especially in all sensory experience: the bare presentation or sentience or affection of the self and the objectifying factors. These may be in fact or in introspection of varying relative importance or "intensity."

The inherent feelings—pleasure and unpleasure, as well as the Wundtian couples, which are admitted—are then forced, despite Parr's explicit denial, into the position of invariable characters or attributes of this sentience. Perhaps it would be fairer to say that they become the differentiating characteristic of such sentience. The more variable feeling tone, which is what everyone else means by the term, is simply a secondary reaction associatively aroused. The primary sentience, because objectively aroused, is more likely to be objectivated; the secondary sentience is similarly less likely to be objectivated. Hence the latter is more likely to provide the ordinary feeling tone of the whole fusion. Plausible as this may all be, it is

extraordinarily ill stated in terms of feeling and sensation. It would be much clearer if stated in the terms of Ward's presentationism—which is not referred to—or in terms of the contrast of sensation and perception. In any case, the whole thesis cries aloud for the difficult but not impossible experimental attack.

HORACE B. ENGLISH

ANTIOCH COLLEGE

GAULT, ROBERT H. *Social Psychology: The Bases of Behavior Called Social.* New York: Holt, 1923. Pp. x+328.

The appearance of Professor Gault's recent textbook has marked the beginning of a new era in social psychology. Previously texts in this field were written either from the sociological viewpoint or else upon a limited and contestable basis of human instincts. Regarding the latter, Professor Gault says that "It is not possible to build a social psychology upon so-called unalterable *instincts* alone as a foundation, nor yet upon *instinct* apart from habits that are woven with it." Purely instinctive behavior cannot be social. In this there is close agreement with the modern trend as illustrated by such writers as Dewey, Bernard, Kantor, Cason, and the reviewer.

Perhaps the most notable departure, however, has been in the enrichment, from a psychological standpoint, of the content of the science. This is the inevitable result of the turning of the empirical interest of psychologists toward social phenomena. Side by side with such classical topics as fashion, custom, suggestion, and mob phenomena, we find recent psychological research bearing upon the socialization of the individual, the rôle of complex and mental conflict in social life, intelligence levels in the population, the social significance of mental defect and insanity, psychological factors in crime, the psychology of racial adjustments, public opinion, mental peculiarities of leaders and geniuses, and the relation of intelligence to occupation. This book is one of the signs of a shift now taking place from the sociological viewpoint of the group as a whole to the psychological interest in the *individual* in his social aspects and social behavior.

The definition of social psychology given by the author is in harmony with the behavior formulations of Professor Hunter (*General Psychology,* p. 85) and the present writer (*Social Psychology,* chaps. 1, 7). The points of agreement are conveyed in the following quotations (p. 3): "Social psychology in its widest sense applies to a study of interactions among animals. More specifically . . . it

applies to the reactions of members of the human race one to another. This is social behavior. . . . They [the interactions among individuals] *may or may not* be accompanied by a consciousness of the social relation."

For Professor Gault the sense of social unity is basic in social behavior. The imagery of others, their attitude toward us, their community of response with ours, are continually present in our consciousness. The sense of unity is a part of individual consciousness. The social mind theory is dismissed as an entirely " unnecessary concept." In agreement with a number of writers nationality is defined as the consciousness of a large number of individuals of " belonging together as a ' nation.' "

Professor Gault adopts the position that *" Instinct* connotes a native undifferentiated structural or dispositional background, the source of undifferentiated drive toward activity: analogous to a dammed-up body of water that may be used to turn any one or all of hundreds of wheels. *Instinctive act* connotes a specific form of behavior that is assumed to have a tap root in the reservoir, and the term *instincts* is applied—to particular inborn mechanisms supporting specific forms of behavior. Clearly there may be *instinct* and *instinctive* behavior, but not *instincts"* (p. 42). Much of the vagueness and metaphorical character of these definitions could have been avoided by an analysis of specific habit formations. The reviewer's position is that the undifferentiated reservoir (instinct) really consists of a group of simple but definite, inborn, reflex acts (which he has elsewhere termed " prepotent reflexes "). These are simpler than the alleged instincts of the McDougall-Thorndike school, and are demonstrable at the beginning of life. It is the failure to analyze these elementary responses underlying habit acquisition, combined with the feeling that there must be *some sort of innate source* for all human behavior, that has led to the vague analogy of a reservoir of original and undifferentiated energy. *Instinctive act,* following this restatement, would be equivalent to a habit in which may be recognized the simple, innate, dynamic factor. It is, in other words, a *prepotent habit.* Professor Gault's position is therefore fundamentally sound, but lacks clear physiological definition.

The modification and social functioning of the instinctive equipment is well discussed. A certain vagueness, however, is to be found in the treatment of " complex." The meaning of this concept as discovered and employed in psychoanalytic use necessarily involves conflict and dissociation. This use is suggested by the author, but is

deprived of its force by broadening the term to include masses of integrated interests and habits, such as the civic complex, the occupational complex, and the like. These, in a manner analogous to secondary attention, become derived drives or motives underlying behavior. Motivation arising from repressed drives and motivation from uninhibited systems of habits are, in the reviewer's opinion, separate facts, and should not be confused.

The chapter upon "Intellectual Levels and Psychic Stability of the Population" is a careful sifting of census statistics, school surveys, and army intelligence test findings, with a view to determining the average intelligence level of the population and the incidence of feeblemindedness. Psychic defects other than feeblemindedness are also discussed. Racial differences in mental capacity are treated with the author's prevailing conservatism. The reviewer feels that the facts available provide ground for a more decisive statement of the intelligence level of the negro than is presented in this chapter. The well-established fact of inferior mental status is not inconsistent with the table, showing the negro's progress, on page 99. Wide educational possibilities of a practical and social nature exist within the limits of an eleven- or twelve-year-old mentality. For the sake of the student, definite and positive assertions should be made wherever the facts warrant. The data upon other races of course is so meager as to justify reporting the findings with careful reservation. Certainly the results of army draft testing merit greater attention than the opinions regarding racial characteristics emphasized on pages 107–110. The scientific attitude (pp. 110–118) may be exaggerated into a defense against seeing intellectual differences that truly exist. The work of Professor Boas, which the author quotes at some length, has probably been misconstrued by some writers to support the assumption that racial differences do not exist! Surely this error is as great as the racial condescension of the LeBon school and the "Nordic worshippers."

Professor Gault has based his treatment of suggestion upon Professor Titchener's excellent definition of suggestion as "any stimulus, external or internal, accompanied or unaccompanied by consciousness, which touches off a determining tendency." Following also a definition of Bunnerman, the author arrives at a statement of suggestion as an indirect awakening of a determining tendency, not in full consciousness, and accompanied by the conviction of reacting on one's own initiative rather than to external influence. Mass-effect, one of the subtopics discussed, is illustrated by some interesting material on

the growth of a rumor in Germany during the late war. The use of suggestion for social control is limited by racial and other native differences, prejudices due to social status, and inequalities of education and experience in different social classes. The discussion of crowd and mob action is creditable, though the definition of crowd as a "leaderless group" is not in keeping with current usage.

Fashion is described by the author as a protest against the conventional, and a medium for self-distinction. The obvious element of conformity to styles adopted by the leaders seems to be overlooked. Under the head of "the audience," "discussion," and "public opinion," some vital conceptions are offered. The definition of public opinion as a sifted product lying on a higher plane than the average opinion of individuals savors slightly of the "group mind" fallacy; but it points out the vital connection of public opinion with discussion and popular government. Custom, convention, nationality, and morale are treated in a traditional manner, with interpretations drawn from the writings of Professor Pillsbury and G. Stanley Hall.

The change involved in "social progress" is for Professor Gault an "inner alteration of the personality" reflected in the external relationship of persons. It is a gradual but "increasing occurrence amongst the personnel of a community of sympathetic coöperation toward a common goal." It cannot be imposed from without by the edicts, or paternalism, however wise, of a leader. It must wait upon developments from within. Intellectual and executive types of leaders are distinguished, and space is given to psychopathic traits in some noted leaders of history. Statistical material, derived from Professor Cattell, is presented dealing with the rôle of nationality and section of the country in the production of eminent men of science. The findings of Professor Terman upon the general superiority of intellectually gifted children are reviewed, and the need emphasized for discovering and fostering genius among our school children.

There is an extended discussion of the present-day unrest in industrial and political relations. Causes which are assigned are mental instability, war strains, change to methods of machine manufacture, enforced methods of social control, exploitation by governments, compensatory trends for failure in adaptation and unfulfilled wishes, feeling of uncertainty in regard to the whole industrial future. The problem of unrest belongs largely to the psychiatrist, and centers in the psychopathic personality and the migratory unemployed. Mental defect plays a much less important part in crime than was

formerly supposed. Temperamental factors, psychic instabilities, and the like are concepts which are replacing the intelligence level in the study of delinquency. Army findings (from military prisons) show that low intelligence is a greater factor in the less serious delinquencies than in those of graver concern. "Habit-formed traits" of character are also important causes in criminal behavior. Suggestions looking toward a remedy for social maladjustments include an "alteration of the stimuli" to antisocial conduct, and relief from the pressure of unfulfilled wishes. It is strange that the educational employment of psychoanalytic procedure was left unnoticed. On the whole, much more could have been made of the problem of social unrest had the author dealt in concrete, individual terms with mental conflict as a cause of maladjustment.

The work closes with some broad practical considerations under the head of "Potentiality for Development of Civilization." Are the mental capacity and the stability of our population increasing or decreasing? Available facts are difficult to interpret. Vital statistics show an increase in the hardihood of the race and the mastery of the problems of hygiene. Despite the eugenist's cry of low birth rate among intellectual classes, no sufficient evidence exists for the decadence of the race and the losing of ability to maintain our present level of civilization. The modern city produces certain deteriorating agencies. But these are counteracted by compensatory and negative adaptation. Conditions and methods of work, effects of drug stimulants, dietetics, and the like are being studied with a view to counteracting the tensions incident to modern living. The World War brought about a degree of mass and coöperative effort which illustrates the potentialities existing for social improvement when the necessary motivation is furnished. The human nervous system has endless capacities for synaptic modification in the learning of new forms of adaptation. While there is a need for specialization and technical education, it is equally necessary to stress the broader social relationships of vocational life and the need for a group of non-specialist leaders who can "think in the large outlines of the whole web of civilization."

The appendices consist of a description of the army mental tests and of a list of references and exercises for the various chapters.

The work throughout is cautious and conservative. It achieves no mastery of the obscure and disputed problems in social psychology, is limited in theory, and restrained in assertion; but it contains much solid material which should recommend it for use as a class text.

Since it is a pioneer in the newly conceived field of social psychology, its shortcomings must be charitably viewed. And, after all, the author's modesty of statement, his social optimism, and his experience with psychology as an instrument for amelioration—all commend him as a well-qualified exponent of psychology within the social field.

FLOYD H. ALLPORT

SYRACUSE UNIVERSITY.

DOWNEY, JUNE E. *The Will-Temperament and Its Testing.* New York: World Book Co., 1923.

In the preface to *The Will-Temperament and Its Testing,* Dr. Downey says: "Work on temperamental testing is still in the pioneer stage; it is, therefore, with some diffidence that I present this book." The material is offered therefore as "suggestions rather than [as] ripened conclusions." It turns out, however, that the author delivers more than is promised. The suggestions are unusually rich; fruitful paths are not merely pointed to, but traced in some detail.

Unlike many adventures in the devising of "mental tests," this one reveals the salutary influence of a sound psychological background both upon definition of aim and in the selection of methods. In the field of applications, since the days of Binet, the cognitive functions have received much attention at the point of sensory discrimination, perception, judgment, and thought. Dr. Downey directs attention to the testing of the executive functions. And here the aim is to discover not *what* particular muscular response the organism will make, but the *manner* of making it; the distinction between the "what" or content, and the "how" or form, is operative in the definition of the problem. Action involves the expenditure of nervous energy. How much is expended? Does it tend to discharge immediately into the motor areas innervating muscles and glands; or, on the contrary, does it tend to find a way out by a round-about pathway of discharge? This physiological conception functions as a heuristic principle in the determination of these tests. If it is possible to devise a set of tests for determining the general level of activity or impulsion, the degree of inhibition, and the modes in which impulsion and inhibition function in the individual, we should then have a valuable index of the action—or "will"—aspect of temperament. A distinction is thus made between this actional aspect and the affective aspect of temperament. Dr. Downey is con-

cerned with the first of these. So much for general orientation as to the author's purpose.

The tests themselves are developments from the author's extensive studies of muscle-reading and handwriting. Profitable modifications were made possible by suggestions emanating from others who for some time had been using the tests.

Three groups of attributes emerge that lend themselves, in the opinion of the author, to such testing: (a) speed of action, (b) aggressiveness, and (c) carefulness and persistence in decision and action. Under these heads the author places a number of specific characteristics. The twelve attributes selected are: (1) speed of movement; (2) freedom from inertia or load; (3) flexibility; (4) speed of decision; (5) motor impulsion or "drive"; (6) suggestibility, or degree of assurance in the face of contradiction; (7) resistence to opposition; (8) finality of judgment; (9) motor inhibition; (10) interest in detail; (11) coördination of impulses; (12) volitional perseveration. These characteristics or attributes of individual behavior, when evaluated somehow on a scale of ten, give us what Dr. Downey calls the "will-profile" of a person. The traits are indicated on the x-axis and the scale on the y-axis of a prepared form. The score-points are connected by lines and the resulting "profile" becomes meaningful to the examiner familiarized with these graphs. For the benefit of the casual reader an explicit statement might have been added, pointing to the fact that these graphs, pictures, "profiles," are not to be thought of as partaking of the nature of the plotted curves of mathematical *formulae*, inasmuch as the profiles do not represent a relationship between two variable quantities. There has been a real danger in connection with some mental tests that the machinery of evaluation and tabulation has borrowed sometimes an appearance of "scientific" finality and "clinching" that is not always warranted and that can be exploited by the unscrupulous to hoodwink the public. In regard to this point, however, the author has done much, by her very manner of presentation, to induct those interested in the tests into a genuine understanding of psycho-physiological mechanisms. The significance of the tests is brought home by a richness of concrete description and by a successful presentation of subtle introspective detail, all under the influence of an abiding respect for common sense, that dispels heaviness and discourages buncombe.

The tests recommend themselves for use in education, social work, vocational guidance, and medicine—indeed, in any field in which there

is any serious commitment to consider at all deeply the question of the possibility of making or re-making, or of realizing upon, human character. And in the reviewer's opinion its chief value may be found by some to lie in the fact that it furnishes to the individual himself a means not only for becoming acquainted with himself but also for becoming in a measure and at certain points his own educator and guide, and perhaps even his own healer.

But to psychology itself Dr. Downey's work may render the service of helping to make more definite some of the questions that bear specifically on the problem of the nature of character. The author, obviously fortified by a sound psychological insight and by an acquaintance with the history of the problem of human conduct, presents a piece of work that stands out, by reason of its unity and method, from many of the chaotic jumbles so often presented under the name of "tests." Action and emotion are fields that have not yielded large harvests in systematic psychology. Bound up, as they have so long been, with the conception of "instinct" and its teleological implications, they have lent themselves to much discussion in connection with the biological ends, purposes, or uses of the various actional and emotional systems. But there was little aggressively prosecuted analysis. This is true not only of the traditional introspective psychology but also of the later behavioristic treatment. It may, then, well be a matter for surprise that a venture avowedly applicational should seem perhaps to contain promising beginnings for a scientific psychological treatment of the fields of action and emotion divorced from such teleological considerations. One illustration of the point will suffice. It is the clear-cut case, cited above, of the distinction of content and manner of action. The author does not seek to determine, for instance, in a hand-shake or in picking up a penny, the presence or absence of some hypothetical "instinct" or actional tendency—let us say "sociality" or "thrift" or "hoarding" —but attempts to determine in the individual case the attributes, such as speed, accuracy, and other more subtle marks, of action, irrespective of what the act or its purpose may be. To the discerning this deviation of the author from the current procedure of many psychologists, whether dealing primarily in principles or in applications, will be significant.

CARL RAHN

UNIVERSITY OF ILLINOIS

NÄSGAARD, SIGURD. *Die Form der Bewusstheit.* München, 1923. Ernst Reinhardt. Pp. 164.

The author is striving after "clearness concerning the relation between the consciousness of objects (Bewusstheit as distinguished from Bewusstsein) and the remainder of the life of the soul." He asserts that he has found a new way of obtaining this clearness by a special method of analysis. His analysis leads to the conclusion that those psychologists who divide the life of the soul into three parts are wrong. The author divides it into five divisions: sensations feelings, strivings, concepts, and consciousness. Of the first four the author asserts that they probably comprise an infinite number of objects. To the fifth he ascribes only one object, namely, the consciousness itself with its peculiar form.

Within the consciousness he discovers various "positions" (Stellungen) which are characteristic of "the form of the consciousness." Animal psychology has proved, the author tells us, that there is no reason for assuming that there is in the animal's consciousness any further "position" than these two: the adjustment position and the object position (Einstellerstellung und Gegenstandsstellung). If this be granted, the transition from the animal to the human consciousness must be "a real evolution."

Psychologists who regard their science as a mixture of logic and metaphysics will find in this very readable book a wealth of clever observations, so that it is quite difficult to single out a few for the purpose of quoting them in this review. But the reviewer humbly confesses that to him these observations are nothing but galimatias. That psychological science will be advanced by them he does not expect.

MAX F. MEYER

UNIVERSITY OF MISSOURI

HERTZ, PAUL. *Ueber das Denken und seine Beziehung zur Anschauung.* Erster Teil: Ueber den funktionalen Zusammenhang zwischen auslösendem Erlebnis und Enderlebnis bei elementaren Prozessen. Berlin, 1923. Julius Springer. Pp. 167.

The author in the preface and introduction calls the reader's attention to the fact that this book desires to be taken as a philosophical and not as a psychological book. This fact greatly simplifies the reviewer's task. The book is essentially a collection of studies in various phases of logic. In the fourth chapter the author treats the

nature of the mathematical thesis. The reviewer feels that he knows enough mathematics to express the opinion that mathematical science will not be advanced by this discourse on the mathematical thesis. The next two chapters treat the perception of space and the abstraction of space (den relativen und absoluten Raumsinn). Another chapter treats "equality transcendencies and other transcendencies."

A great deal of labor is spent on proving that there is a difference between "functional induction" and "generalizing induction." That may please certain logicians. From the psychologist's point of view the reviewer expresses the opinion that this labor is lost. He is becoming more and more convinced that the late war has had the effect of driving German philosophy back into Hegelism. But perhaps the position of cause and effect should be exchanged in this statement. Maybe the war was the effect of the already existing Hegelism, going under the name of "German idealism."

MAX F. MEYER

UNIVERSITY OF MISSOURI

BOVET, PIERRE. *The Fighting Instinct.* (Trans. by J. Y. T. Grieg.) New York: Dodd, Mead, 1923. Pp. 252.

In this comprehensive monograph Bovet has done for the fighting instinct what Freud and his disciples long since accomplished in the analysis of the sex instinct. The reader who is willing to grant that every cruel impulse is based upon sadism or masochism, that all fighting is to be referred to the struggle for a mate, that all "fighting play is, in principle, copulation play," will find this a most interesting contribution to psychoanalytic literature. The reader who is not willing to grant these rather sweeping premises will nevertheless encounter much that is good.

The early chapters present an analysis of children's quarrels, fights, and teasing, based largely upon evidence presented by the children themselves in the form of compositions. Play activities are considered also and the general conclusion drawn that both the play and fight of the child are propaedeutic to the sex struggle of adult life. There follows a thoroughgoing analysis of the fighting instinct as regards its continuation, canalization, complication, deflection, objectification, subjectification, Platonization, correlation, and sublimation.

Other writers have pointed out the relation between religion and sex; Bovet here shows that religious experience involves the sub-

limation of the fighting instinct. Another chapter deals with the complication of the instinct in various vocations, with particular reference to that of the professional soldier. In discussing the fighting instinct and human evolution the writer distinguishes three stages in the sublimation of the instinct in the individual. In the first stage the instinct asserts itself in the crude form of physical behavior; in the intermediate stage, the physical behavior, though still in evidence, is justified by the ideal of service; in the final complete sublimation the primitive behavior has completely disappeared and the psychic forces are utilized for the good of society. A similar evolution occurs in the development of political states. A few remote primitive tribes may still be in the first stage, but most modern states are in the intermediate stage of sublimation. They fight as hard as ever, but brutal acts are committed only in the service of some ideal—the fatherland, liberty. Modern warfare, then, cannot be considered as due to a regression of the fighting instinct, but rather to its incomplete sublimation. If this sublimation is ever to be complete it will be as the result of education, and the final chapters deal with the specific problems involved in the three types of education chiefly concerned, namely, military, moral, and pacifist.

The book is of particular interest because it was first published during the war, the author being a professor at the University of Geneva. At that time the fighting instinct was uppermost in the thoughts of the world, and the author discusses the war freely. However, the fact that six years have elapsed since the conflict ceased makes the work no less a valuable contribution to the literature of human instincts.

KARL G. MILLER
UNIVERSITY OF PENNSYLVANIA

FREDERIC LYMAN WELLS. *Pleasure and Behavior.* New York: Appleton, 1924. Pp. xvi+274.

The place for an extended review of this volume is in the weekly book reviews of our metropolitan newspapers and in the magazines. It is to be hoped that it will receive there the commendation which it so completely deserves. In this place, one might, as is a frequent custom, use the book as a point of departure from which to expound one's own views on certain controversial topics. It would be dogma against dogma and may the best authority win. But since Wells' credit in these matters is greater than mine, there would be little profit in that.

I do not mean that Wells has given us a work written in a pontificial and dogmatic style. Far from that. He has written an exceedingly pleasant and witty account of different kinds of pleasures and their place in a full life. It is intended for intelligent persons who are interested in things psychological. Some of them will have had "Three hours a week for one semester, three hours credit"; many will not. In addressing such an audience, Wells seems to me very properly to avoid difficulties which become real only when one has a wider grasp of psychological fact and concept than most such readers will ever have. What he has done is to summarize in an intelligible way such facts and such probable theories related to his title as will be helpful in the "Conduct of Mind." The professional psychologist will read with considerable pleasure. Where he differs from Wells, he is apt in most cases, it seems to me, to reflect that after all probably that is not a difficulty which needs airing in a semi-popular discussion.

The awful fear lest I have betrayed a want of critical acumen leads me to add a note of skepticism about the relation of the first chapter to the rest of the book. It is a beautifully concise statement of the author's psychological articles of faith. The psychologist will not have difficulty in determining where F. L. Wells stands on most points of system. Nor, since it is not hard reading, will the general reader balk at skimming through this chapter; he will think that he understands. The reviewer doubts, all the same, that he will. There can be too much *nultum in parvo*. Most of this introductory material is not directly called for in the main text; its sole value is to provide a general orientation and this cannot be done in psychology in one chapter. The material directly needed in the succeeding chapters could be brought in when and as needed.

HORACE B. ENGLISH

ANTIOCH COLLEGE

MATEER, F. *The Unstable Child*. New York: Appleton, 1924. Pp. xii+471.

This book summarizes in very readable form what every good clinical psychologist knows and practices, but what the public at large as yet only dimly perceives.

After a discussion of the origin of clinical psychology and recent tendencies in this field, Dr. Mateer presents some of the psychological

problems of to-day—problems for which the method of group testing and even the careful individual examination resulting in a mental-age rating have been unable to furnish a solution. The unstable child is frequently not feebleminded by mental tests. Individuals who show symptoms of a neurotic nature, who attempt a flight from reality, have temper-tantrums, are pathological liars, are repeatedly delinquent, "can't concentrate," or who are "bright," but in some peculiar fashion fail to make their grade promotions—these children must be studied by the methods of a clinical psychology that takes into account in its diagnosis some of the less tangible qualitative results of the intelligence examination. Dr. Mateer believes that the diagnosis of "psychopathy"—wrong mental function—or even of congenital syphilis is facilitated by taking into account the following points: "(1) The range above the basal on the Stanford; (2) The distribution of successes and failures on the Stanford; (3) The quality of individual responses on the Stanford; (4) The distribution of the word reactions values on the Kent-Rosanoff association series; (5) The quality of the individual responses on the Kent-Rosanoff association series; (6) The presence of imbalance on various performance-test ratings, and the relation of such scores to the Stanford mental age; (7) The educational ability of the individual viewed in the light of his mental age on the Stanford; (8) The general orientation of the individual; (9) The patient's own story of himself and his experiences; (10) The behavior during the examination, supplemented by reports of behavior while under institutional living."

The book contains many case studies of delinquents examined at the Ohio Bureau of Juvenile Research, and offers numerous suggestions for means and methods that will prove useful to teachers, students, and inexperienced examiners.

LORLE I. STECHER

STATE UNIVERSITY OF IOWA

NOTES AND NEWS

DR. L. L. THURSTONE, of the Bureau of Public Personnel Administration, Washington, D. C., has been appointed associate professor of psychology at the University of Chicago.

DR. DONALD A. LAIRD, of Yale University, has been appointed associate professor of psychology at Colgate University.

GEORGE C. FRACKER, head of the department of psychology at the University of Dubuque, has been appointed professor of psychology and philosophy at the University of Arkansas.

DR. ARNOLD PICK, emeritus professor of psychiatry in the University of Prague, has recently died at the age of seventy-five years.

DR. KARL S. LASHLEY has been promoted to be professor of psychology at the University of Minnesota.

DR. WOLFGANG KOEHLER, professor of psychology at the University of Berlin, will be visiting professor at Clark University for a year, starting in February, 1925.

PROFESSOR KURT KOFFKA, of the University of Giessen, has been appointed acting professor of education at Cornell for the year 1924–1925. He will arrive in September and will offer courses in education, educational psychology and will give a series of public lectures on the Gestalt Theorie.

DR. FLOYD H. ALLPORT, formerly associate professor of psychology, University of North Carolina, has accepted a professorship of political and social psychology in the new School of Citizenship and Public Affairs, to be opened this fall at Syracuse University.

DR. EDWIN G. BORING, associate professor of psychology at Harvard University, has been appointed director of the Howard Psychological Laboratory.